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AN INVESTIGATION OF THE IMPROVEMENT OF EDUCATIONAL FILMSTRIPS AND A DERIVATION OF PRINCIPLES RELATING TO THE EFFECTIVENESS OF THESE MEDIA--STUDY I.

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PHASE ONE OF A STUDY TO DETERMINE THE EFFECT OF REVISED FILMS ON THE PRODUCTION OF SIGNIFICANT LEARNING BEHAVIOR WAS REPORTED. THE FILMSTRIP, "THE SUN AND ITS PLANETS," WAS SELECTED AND SHOWN TO GROUPS OF FIFTH-, EIGHTH-, AND TENTH-GRADERS. A TEST COVERING THE CONTENT OF THE FILMSTRIP WAS PRODUCED AND VALIDATED. THREE PHASES WERE IMPOSED IN THE RESEARCH DESIGN. THE FIRST VERSION OF THE TEST OF LEARNING FROM THE ORIGINAL FILMSTRIP WAS ADMINISTERED TO 276 SUBJECTS AND VALIDATED. PHASE TWO INCLUDED THE COLLECTION OF DATA FOR THE FIRST REVISION. THE ORIGINAL FILMSTRIP WAS SHOWN TO ANOTHER POPULATION OF 253 PUPILS. PHASE THREE INCLUDED THE COLLECTION OF COMPARISON DATA OF THE REVISED AND ORIGINAL FILMSTRIP. STATISTICAL ANALYSES WERE EMPLOYED ON THE RESPONSES FROM THE ACHIEVEMENT TESTS. THE RESULTS INDICATED THAT CERTAIN REVISIONS WERE SUCCESSFUL, BOTH IN PICTORIAL AND CAPTION PORTIONS OF THE FILMSTRIP. PHASE TWO AND THREE OF THIS PROJECT REPORT WERE ASSIGNED ACCESSION NUMBERS ED 003 534 AND ED 003 535 RESPECTIVELY. (RS)

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AN INVESTIGATION OF THE IMPROVEMENT OF EDUCATIONAL FILMSTRIPS AND A DERIVATION OF PRINCIPLES RELATING TO THE EFFECTIVENESS OF THESE MEDIA, PHASE 1. REV. OF.

PHASE I REVISION OF

FILM STRIP–THE SUN AND ITS PLANETS - -

U.S. Office of Education Grant No. 736049

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AN INVESTIGATION OF THE IMPROVEMENT OF INFORMATIONAL FILMSTRIPS AND THE DERIVATION OF PRINCIPLES RELATING TO THE EFFECTIVENESS OF THESE MEDIA

STUDY NO. I

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Mr. Jack Morrison assisted in reviewing tests and in the administration of the filmstrip and post tests.

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CHAPTER I

Introduction

The filmstrip was developed about the time of World War I and came into very wide use after World War II. The "man on the street" would undoubtedly opine that there have been significant qualitative changes in the filmstrip during the past half century, and he probably would be right, although there has been very little analytical research on the filmstrip as a medium of communication. This is not to say that the works of Spaulding, Buswell, Williams, and others regarding the still picture as stimulus material are irrelevant, but none of these did deal directly with the filmstrip as such.

In one study[1] a filmstrip was compared with a printed script covering exactly the same information. It was found that as many frames tended to elicit wrong responses as tended to encourage right responses among learners. An analysis of the filmstrip frames that produced "negative learning" resulted in the formulation of a number of hypotheses as to how they could be improved; for example, in some instances the most noticeable element of the picture was not the most important in conveying meaning. In other instances, the pictorial and verbal elements seemed to compete with each other rather than to supplement and reinforce each other. In still other cases, captions appeared, from test results, to be as best, ambiguous.

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1. VanderMeer, A. W. "Relative Contributions to Factual Learning of the Pictorial and Verbal Elements of a Filmstrip." School Review: Volume 58, pages 84-89.

Objectives of the Research

The purpose of the present research was to determine the extent to which systematic study of pictorial and graphic materials in filmstrips and their accompanying verbal captions could be translated into revisions of these filmstrip elements in such a way that the revised filmstrip would produce significantly more learning than the original. To the extent that such improvements could be effectuated, theoretical principles might emerge.

A subsidiary purpose of the study was to demonstrate a procedure whereby research workers might cooperate with filmstrip producers and public school people in the improvement of filmstrip materials.

General Procedure

The general procedure used in the present study was as follows:

(1) An informational filmstrip of general curricular validity was selected. The content had to be such as to be useful from upper elementary grades through high school. Such a filmstrip was the one used in this study; namely, "The Sun and Its Planets", produced by The Society for Visual Education.

(2) As many four-choice multiple choice items as possible were written to cover the pictorial and verbal content of the filmstrip. Pictorial and graphic representations were used as needed in the test items.

(3) The test items appearing to have greatest face validity were administered to populations from grade 5 to grade 12, and a revised

test was developed on the basis of statistical analyses of responses to the original items.

(4) On the basis of the proportion passing given test items or groups of items, and through an examination of the distractors that attracted a significant number of responses, it was possible to identify frames and captions that appeared to be relatively ineffective in communicating the information that they contained.

(5) Based on the data mentioned in (4), and on the basis of experience, intuition, and imagination, the investigator and his assistants developed hypotheses as to how the original filmstrip (hereinafter referred to as FSO) could be revised so as to improve its communicative effectiveness without changing its informational content.

(6) In a conference between the investigator and his assistants, the producers[1], the educational consultant employed by the producer, and a filmstrip artist, decisions were made as to what revisions would be accomplished.

(7) After the artist had prepared rough approximations of the revisions, the investigators checked the revisions to see that the changes agreed upon were clearly made.

(8) A revised filmstrip, hereafter referred to FSR, was prepared by the producer.

---

1. John C. Kennan and Walter Johnson. Society for Visual Education, Inc., 1345 Diversey Parkway, Chicago 14, Illinois.

(9) The revised and original filmstrips were shown to randomly constituted halves of population samples ranging from upper elementary to senior high school levels under controlled experimental conditions, and the filmstrip test was administered. Each group saw only the revised or the original, never both.

(10) Judgments as to the effectiveness of the revision were made on the basis of mean test scores on content covered in the original and revised filmstrips, and of differences in proportions passing items covering information presented in revised frames, as compared with the proportion passing items covered in the original version.

Terms Defined

1. FRAME . . . that portion of the filmstrip intended to be seen in its entirety at one time.
2. FSO . . . the original filmstrip.
3. FSR . . . the revised filmstrip.
4. Phase I . . . that part of the research given to the construction and validation of the testing instrument.
5. Phase II . . . that part of the research given to the collection of data and the revision of the selected filmstrip.
6. Phase III . . . that part of the research given to the experimental comparison of the original filmstrip and the revised filmstrip to determine the effectiveness of the revision.
7. Delayed testing . . . testing conducted after the entire filmstrip had been shown.
8. Immediate testing . . . testing conducted after each frame of the filmstrip had been shown; e.g., show a frame, then test on that frame.

CHAPTER II

PROCEDURES FOLLOWED IN THE INVESTIGATION

Selection of Filmstrip

Since one purpose of the research was to demonstrate how research personnel in a university can collaborate with commercial producers of instructional materials in order to improve the materials, the first step was to select an interested producer. The President of the Society for Visual Education, Mr. Jack Kennon, enthusiastically agreed to work with the principal investigator and his assistants in studying at least two filmstrips in the manner described in the general procedure of the study.

It was intended to use school populations in the study; therefore, it appeared that the experimental filmstrips should teach content that would ordinarily be taught in schools. Furthermore, a filmstrip that had had general acceptance as valid and useful curriculum material seemed to be needed. It obviously would be unwise to use a filmstrip of which the producer was not proud. Finally, the filmstrip should be primarily related to the objective of concept development, and rich in factual content. Such a filmstrip was "The Sun and Its Planets".

Only the first forty frames were used. The investigators' judgment in this case was that the filmstrip and a test covering the entire content would unduly fatigue fifth grade students.

Selection of Populations Samples

Separate population samples were needed (1) to validate the test produced to cover the content of the filmstrip, (2) to develop a "learning profile" on the original filmstrip in order to have a basis for revision of that filmstrip, and (3) to compare original and revised versions of the filmstrip.

In order to avoid diffusion of information about the research and the content of the filmstrips, the various phases of the research were conducted in separate communities. As part of obtaining the cooperation of school people in these communities, it was agreed that participating school classes would delay studying their units on astronomy until after their part in the research was completed.

The first version of the test of learning from the original filmstrip was validated in the Huntingdon, Pennsylvania, Public Schools. The characteristics of the participating subjects are summarized in Table I.

TABLE I

Population Data on Students from the Huntingdon Public Schools Used for Test Validation in Phase I

Grade	N	Boys	Girls	Age
5	101	57	44	9-11
8	99	48	51	12-15
10	76	32	44	14-17

Phase II, which was the collection of data for the first revision, took place in the city school system of Tyrone, Pennsylvania. In this phase, the original filmstrip was shown to the student subjects. Immediately following the showing, the criterion test as validated in the Huntingdon schools was administered. The two population samples were similar, but no comparison of data was called for by the experimental design.

The characteristics of the subjects used in Phase II are summarized in Table II.

TABLE II

Population Data on Students from Tyrone
Used in This Investigation. Phase II

Grade	N	Boys	Girls	Age
5	68	43	25	9-11
8	102	50	52	12-15
10	83	32	51	14-17

Phase III of this investigation was devoted to the collection of comparison data of the filmstrip revision and the filmstrip original. This phase is divided into two parts: in Part A, the technique employed delayed testing; in Part B, immediate testing was employed. The distinction, previously defined, is between testing after each frame or testing after the entire filmstrip.

Lewistown, Pennsylvania, and Mill Hall, Pennsylvania, were populations for Parts A and B respectively. Tables III and IV summarize information on the students used in testing in Phase III.

TABLE III

Population Data on Students from Lewistown, Pennsylvania, Used in Part A of Phase III (Delayed Testing)

Filmstrip Original				
Grade	N	Boys	Girls	Age
5	82	40	42	10-12
7	94	50	44	12-14
11	108	59	49	16-18
Filmstrip Revision				
Grade	N	Boys	Girls	Age
5	82	42	40	10-12
7	95	52	43	12-14
11	99	60	39	16-18

TABLE IV

Population Information and Data on Students from Mill Hall, Pennsylvania Used in Part B of Phase III (Immediate Testing)

Filmstrip Original				
Grade	N	Boys	Girls	Age
8	57	29	28	13-15
11	42	19	23	16-18

Filmstrip Revision				
Grade	N	Boys	Girls	Age
8	59	28	31	13-15
11	39	23	16	16-18

The total population consisted of 1,286 boys and girls. Table V summarizes the grade level of students who served as subjects in various phases of the study.

TABLE V

Composition of Experimental Groups

Test Validation	Original Version	Revision One			
		FSO	FSR	FSO	FSR
Grade 5	Grade 5	Grade 5	Grade 5		
Grade 8	Grade 8	Grade 7	Grade 7	Grade 8	Grade 8
Grade 10	Grade 10	Grade 11	Grade 11	Grade 11	Grade 11

FILMSTRIP PRESENTATION AND TEST ADMINISTRATION

Constituting the Experimental Groups. The same proctor presented the filmstrip and administered the test to all groups. Each group saw only one version of the filmstrip. The groups were constituted by combining randomly selected halves of two classes in the following manner. In each of two fifth grade classrooms, boys and girls were randomly designated as in the "A group" or in the "B group". The A group from one room would join the A group from the other room, and their places would be taken in their home room by the B group from the other room. In this manner, the residual effects of being in a particular teacher s class were equalized.

The effects of fatigue and time of day when the presentation was made were controlled for by careful management of the schedule. A value of 1 was assigned to any presentation that (a) was held in the morning (none began later than 10:30) and (b) was the first test session experienced by the students in any given day. A value of 2 was given to any afternoon presentation and to any morning presentation that followed a previous presentation the same morning. There were no second sessions held on any afternoon.

To control for serial effects on the proctor and for proctor fatigue, values of 1 or 2 were assigned on the same basis. Thus a group having a morning presentation which was their first, but the proctor's second, would be assigned a "fatigue factor" of 3 (1 plus 2). Tables Va and Vb show the "fatigue factors" for all groups tested. It will be noted that the sums of the "fatigue factors" for all comparison groups are equal.

TABLE Va

Equating Groups for Serial Fatigue Effects
of Pupil-Viewers and Investigators

Phase III - Part A - Delayed Testing - Lewistown Public Schools

Grade and Section	Filmstrip Version	Time	Pupil-Viewer Fatigue Factor	Investigator Fatigue Factor
11'A	FSO	9:00	1	1
11 A	FSR	10:30	2	2
5B, 5'B	FSR	1:00	1	1
7-5B, 7-6B	FSO	9:00	1	1
7-5A, 7-6A	FSR	10:30	1	1
5A, 5'A	FSO	1:00	2	2
7-1B, 7-2B	FSR	8:30	1	1
7-1A, 7-2A	FSO	10:30	2	2
5'E	FSR	1:00	2	2
7-7A, 7-4A	FSR	8:30	1	1
7-7B, 7-4B	FSO	10:10	2	2
5 E	FSO	1:00	1	2
5D, 5'D	FSO	9:00	1	1
5C, 5'C	FSR	1:00	1	2
5G, 5H	FSO	9:00	1	1
5'H, 5'A	FSR	1:00	2	2
Total	FSO		11	12
Total	FSR		11	12

TABLE V5

Equating Groups for Serial Fatigue Effects
of Pupil-Viewers and Investigators

Phase III - Part B - Immediate Testing - Mill Hall Public Schools

Grade	Version	Subject Fatigue	Proctor Fatigue
8B	FSR	2	2
8A	FSO	2	2
11B	FSO	1	1
11A	FSR	1	1
Total	FSO	3	3
Total	FSR	3	3

Presenting the Filmstrip and Test. The presentations were made in regular classrooms that had been fitted for projection, or in auditoriums. In each case, the projector had been set up, the darkening shades had been pulled down, and other preparations had been made before the students came in.

After the students had taken their seats in the assigned room, the experimenter presented a memorized introduction. For this introduction see Appendix B, page 82.

After the introduction, the proctor turned on the projector, and the title frame appeared in focus on the screen. The title was read, and the filmstrip was advanced. The first frame after the title was then projected without comment for seven seconds; the investigator

then read the printed caption and allowed the frame to remain on the screen for an additional five seconds. The second frame was then moved into position for projection, and the same time schedule was followed, i.e., seven seconds for viewing, having the caption read aloud, and re-viewing for five seconds.

When the last frame had been shown, I.B.M. answer sheets were distributed, and, with the use of the chalkboard, detailed instructions in the proper method of responding were demonstrated. The use of the I.B.M. electrographic pencil was discussed briefly.

The testing instrument was then passed to the students with instructions to begin immediately.

The foregoing procedure was modified somewhat in the immediate testing situation which required the use of two proctors operating in different rooms with different versions of the filmstrip at the same time.

To reduce the possibility of a variance attributable to differing proctor influences, two tapes were prepared in advance by the investigator. One tape was recorded for the original filmstrip, and the other for the revision. Both tapes were recorded using the same voice.

The instrument used for immediate testing was arranged in book form with the questions pertaining to each frame on separate pages. Blank sheets of paper separated each page.

The time allotted to each frame was the same as in the delayed testing, but after each frame the entire group turned over the blank pages on directions from the investigator and responded to the test items pertaining to the frame they had just seen. A copy of the delayed testing instrument is in Appendix C, page 86.

CHAPTER III

REVISIONS AND RESULTS

In the following discussion all frames from the original filmstrip will be referred to as Figure 1A, Figure 2A, and so forth, and those in the revised filmstrip will be matched by number to the original but will carry the letter "B" with the duplicated number. Only those frames in which some revision was made will be discussed.

Frame 3

The major intent in the revision of Frame 3 was to illustrate more accurately the relative sizes of the earth and the sun. The original frame gave accurate information in the caption, but the pictorial element belied the title. The diameter of the sun was given as 108 times that of the earth, but the picture shows only 33 "earths" occupying the sun's diameter. Similarly, some 44 "earths" were shown near the edge of the sun's disc to illustrate that the sun's volume is 1,300,000 times that of the earth. The revision, Figure 3B, shows the attempt of the investigators to resolve the contradiction between picture and caption. It was opined that the contrast between the size of the droplet representing the earth would contrast more vividly with the size of the sun as represented by a hollow ball, and that the volume concept was more striking than the diameter concept.

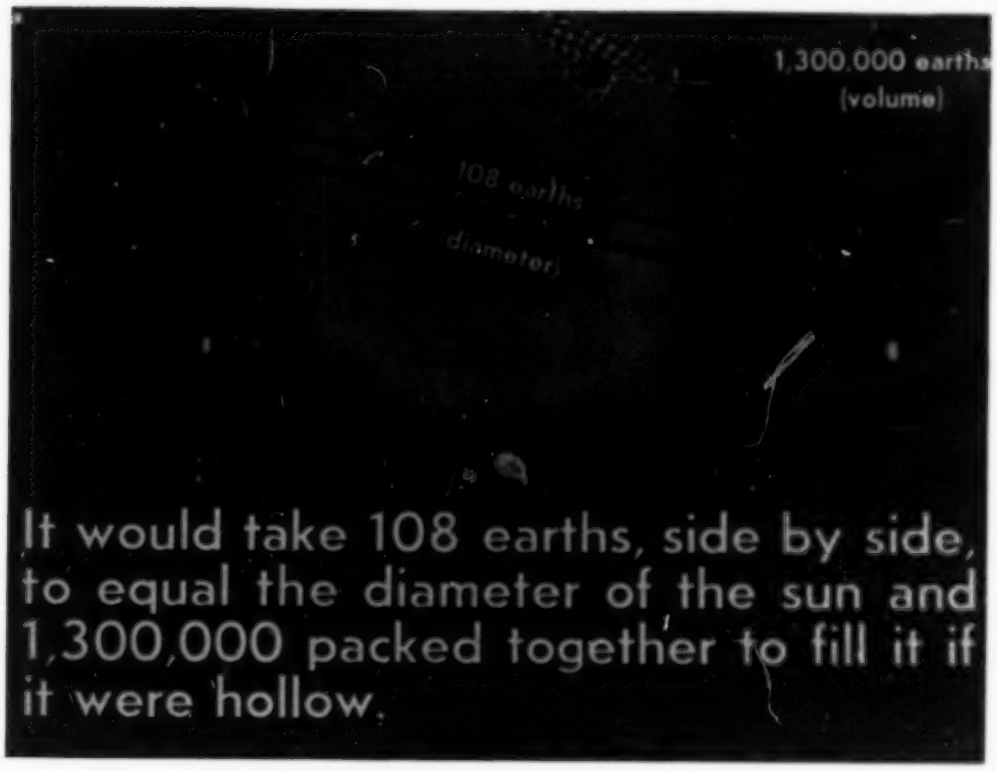

1,300,000 earths
(volume)
108 earths
diameter
It would take 108 earths, side by side, to equal the diameter of the sun and 1,300,000 packed together to fill it if it were hollow.

Figure 1A, Filmstrip Original, Frame 3

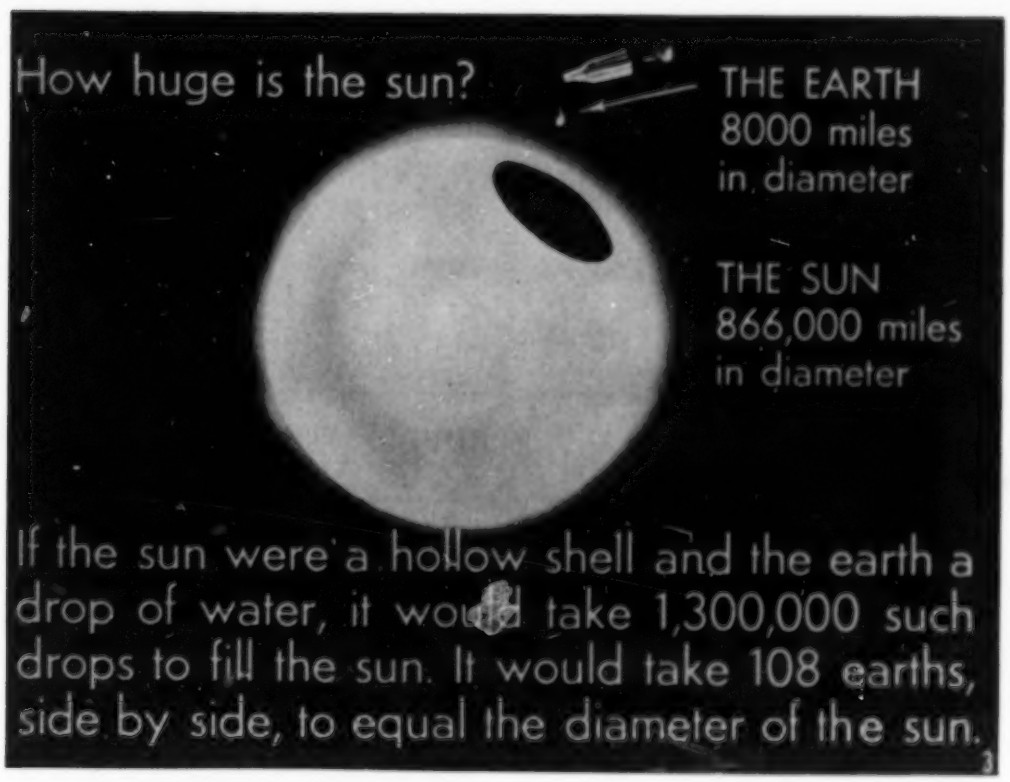

How huge is the sun?
THE EARTH
8000 miles
in diameter
THE SUN
866,000 miles
in diameter
If the sun were a hollow shell and the earth a drop of water, it would take 1,300,000 such drops to fill the sun. It would take 108 earths, side by side, to equal the diameter of the sun.
3

Figure 1B, Filmstrip Revision, Frame 3

The following items were included on the testing instrument:

(Original item number)

4. Approximately how many earths would it take to equal the diameter of the sun:

   1. 50
   2. 100
   3. 1,000
   4. 1,000,000

5. If the sun were hollow, how many of our earths packed together would it take to fill it:

   1. one-fourth of an earth
   2. 1,300,000 earths
   3. 130,000 earths
   4. 3,000,000 earths

Table VI summarizes the responses of students on delayed testing to items dealing with the content of Frame 3.

TABLE VI

Proportions of Students in Delayed Testing Selecting Various Responses[1]

	Item 4					
	Grade 5		Grade 7		Grade 11 (N 108)	
	FSO(N 82)	FSR(N 82)	FSO(N 94)	FSR(N 95)	FSO(N 108)	FSR(N 99)
1.	5	3	1	6	4	6
2. x	14	20	45	39	47	47
3.	31	39	24	29	25	21
4.	50	37	30	26	24	25

	Item 5					
	Grade 5		Grade 7		Grade 11	
	FSO	FSR	FSO	FSR	FSO	FSR
1.	7	3	1	7	1	2
2 x	38	40	44	51	73	51
3.	25	36	26	25	14	32
4.	30	16	28	16	12	15

1. The correct response in every case will be designated with an X. The numbers of subjects responding was the same for all items; therefore, the number will not be repeated after Tables VI and VIII.

It will be noted that the revision did not "pay off" in any spectacular fashion. The majority of both groups were not able to recall the correct relationship between the diameters of the earth and sun. Those seeing the revision made fewer and less drastic errors, but not statistically significant.

In the immediate testing situation, the proportions passing Item 4 in the eighth grade group were 34 and 51 for FSO and FSR respectively. Corresponding figures for the eleventh grade group were 57 and 77. In the eighth grade group 81 per cent who saw the original film passed Item 5, as opposed to 71 per cent of those who saw the revised filmstrip. The corresponding proportions for the eleventh grade group were 67 per cent for the original and 85 per cent for the original.

Frame 4

The pictorial element of Frame 4 was not changed in the revision because it was the judgment of the investigators that the picture had been well selected to cover the content matter. (See Figures 2A and 2B). However, the caption was changed in the interest of accuracy, and to supply a commonly known referent. Unfortunately, the results of this revision can not be assessed because the word "atomic" has been replaced by the word "nuclear" in the caption of the FSR, and the test item was not changed for the FSR group. Because the correct answer parallels the language of the original caption, no valid inferences can be drawn concerning the revision.

6. The sun gives light and heat. This heat comes from:

   1. the reflected light from the stars
   2. energy like that of atomic fusion
   3. fires burning on the surface
   4. molten lava on the surface

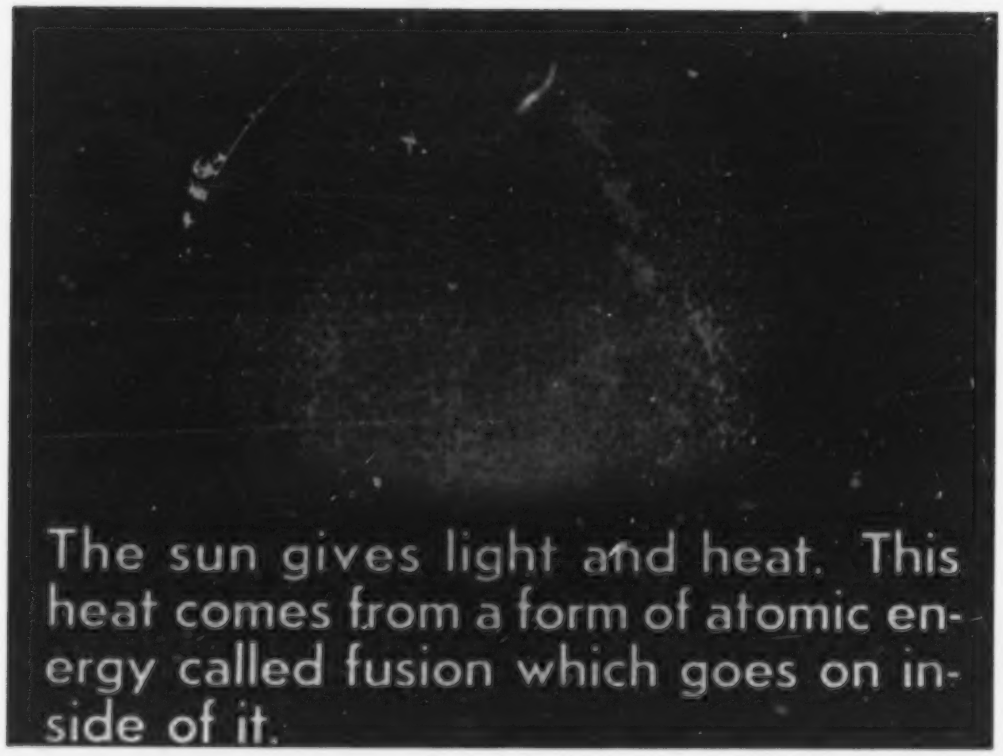


Figure 2A, Filmstrip Original, Frame 4

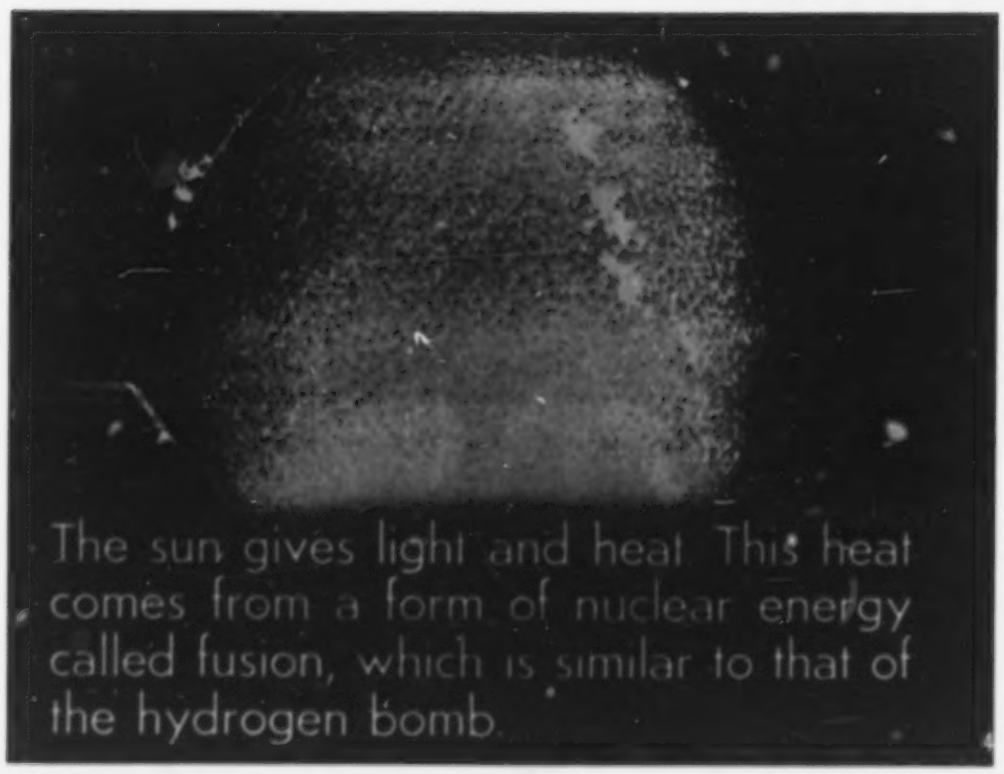

The sun gives light and heat. This heat comes from a form of nuclear energy called fusion, which is similar to that of the hydrogen bomb.

Figure 2B, Filmstrip Revision, Frame 4

Frame 5

Three changes were made in Frame 5 shown in Figures 3A and 3B. The arrows used to indicate the location of sunspots in the FSO when projected on the screen seemed to blend with the sunspots. The revision showed the arrows much more prominently. Furthermore, investigators felt that some reinforcement was necessary in relating the movement of the sunspots to the passage of time. This was accomplished by adding appropriate dates opposite each drawing of the sun (See Figure 3B) to denote a passage of time between observations. The caption was broken into two sentences in the revision, and the meaning of the apparent movement of the sunspots was made more explicit.

The following two items tested information contained in Frame 5.

7. The sun turns on its axis once:

    1. each day
    2. every 10½ days
    3. every 24½ days
    4. each year

8. We can tell that the sun turns on its axis because of:

    1. the changing position of sunspots
    2. the difference in cloud formations
    3. its effect on the earth's orbit
    4. all of these

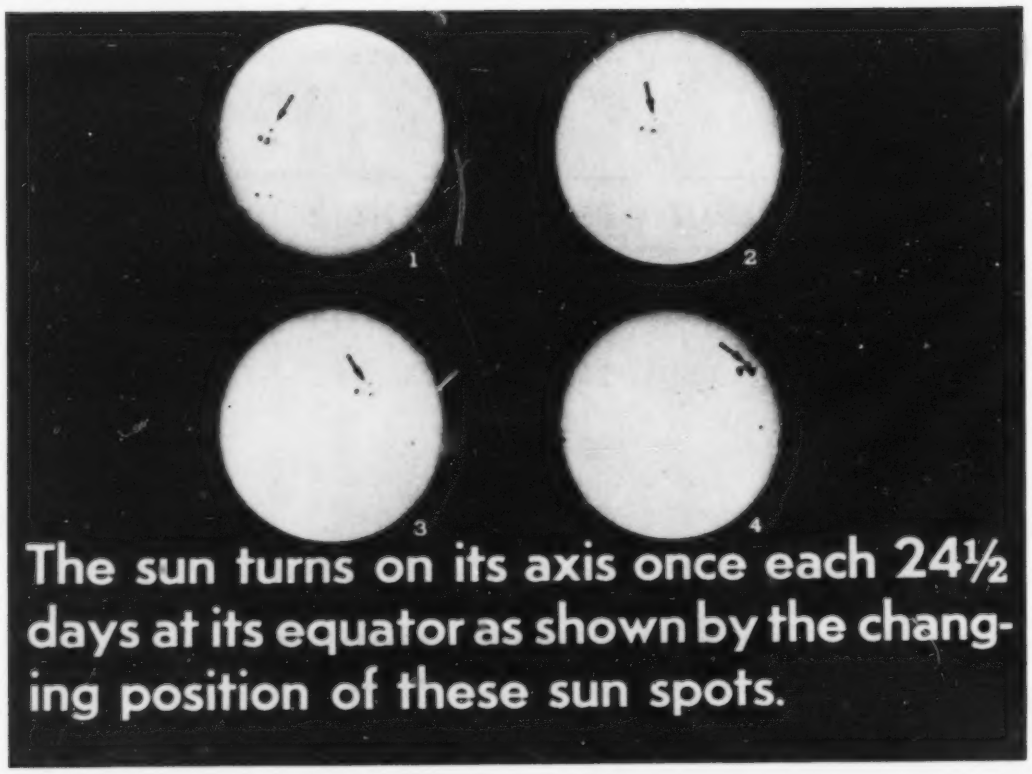


Figure 3A, Filmstrip Original, Frame 5

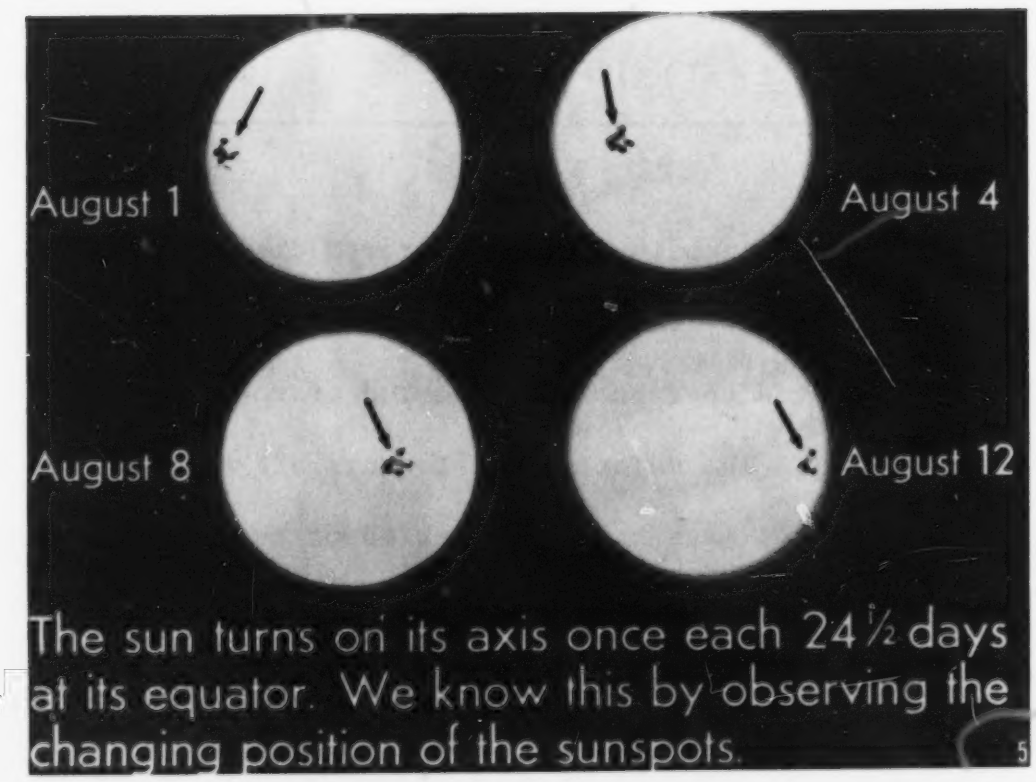

August 1
August 4
August 8
August 12
The sun turns on its axis once each 24½ days at its equator. We know this by observing the changing position of the sunspots.
5

Figure 3B, Filmstrip Revision, Frame 5

TABLE VII

Proportions of Students Selecting Various Responses
to Items 7 and 8

Item 7 - DELAYED TESTING

	Grade 5		Grade 7		Grade 11	
	FSO	FSR	FSO	FSR	FSO	FSR
1.	18	11	24	11	23	20
2.	2	4	3	11	5	1
3. x	48	42	50	59	53	67
4.	32	43	22	19	19	11

Item 8 - DELAYED TESTING

	Grade 5		Grade 7		Grade 11	
	FSO	FSR	FSO	FSR	FSO	FSR
1. x	59	65	70	79	72	74
2.	2	3	4	1	2	5
3.	27	18	13	11	8	10
4.	10	11	12	9	17	11

Both delayed and immediate testing proved disappointing so far as providing data justifying the revision is concerned. Nearly as many fifth graders insisted that the sun's period of rotation is a year as responded correctly. The majority of students did get the idea of how we are able to estimate the sun's period of rotation, however.

Under the immediate testing program, nearly all students responded correctly, but what few made errors were more likely to have seen the revised filmstrip! Perhaps the students who learned, learned

from the caption alone; and those who did not were <u>distracted</u> by the picture. Since the original picture was virtually meaningless, it distracted from the caption less than the "superior" revised picture. If true, this is a bitter pill for the audio-visualist to swallow!

TABLE VIII

Proportions of Students Selecting Various Responses to Items 7 and 8

Item 7 - IMMEDIATE TESTING

	Grade 8		Grade 11	
	FSO(N 51)	FSR(N 59)	FSO(N 42)	FSR(N 39)
1.	0	8	0	0
2.	5	0	0	3
3. x	91	90	100	92
4.	4	2	0	5

Item 8 - IMMEDIATE TESTING

	Grade 8		Grade 11	
	FSO	FSR	FSO	FSR
1. x	82	68	83	97
2.	4	3	0	0
3.	9	17	7	3
4.	5	12	10	0

Frame 6

The verbal content of this frame states, in the original, that the sun moves through space in the direction of the constellation Hercules. If the learner is unaware of the whereabouts of Hercules, this excellent information may be lost on him. It was hypothesized that in this context, it is meaningless and merely adds a distraction to the pictorial content. (See Figures 4A and 4B)

The information about the speed of the sun moving through space is reinforced in a superimposed caption. In the FSR the caption, "12 miles per second" was enlarged and placed above the direction arrow in the lead position. (Figure 4B)

The following item was included in the testing instrument to cover the content matter of Frame 6.

9. The whole solar system moves through space at:

    1. 12 miles per second
    2. 32 miles per second
    3. 52 miles per second
    4. 62 miles per second

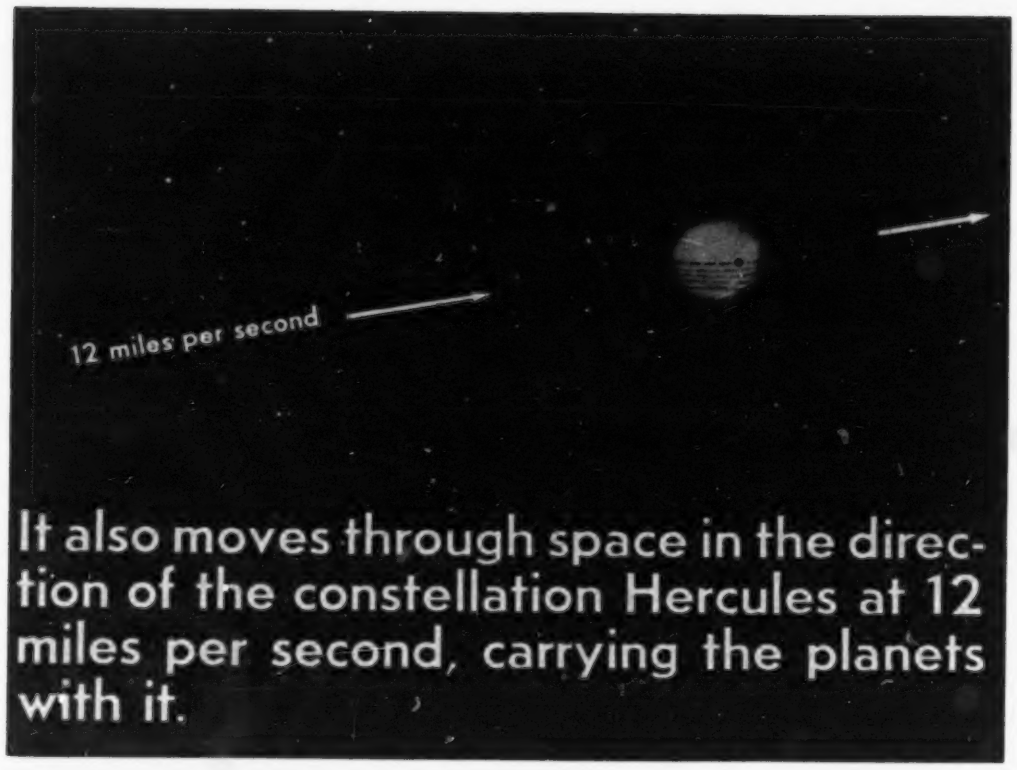

12 miles per second
It also moves through space in the direction of the constellation Hercules at 12 miles per second, carrying the planets with it.

Figure 4A, Filmstrip Original, Frame 6

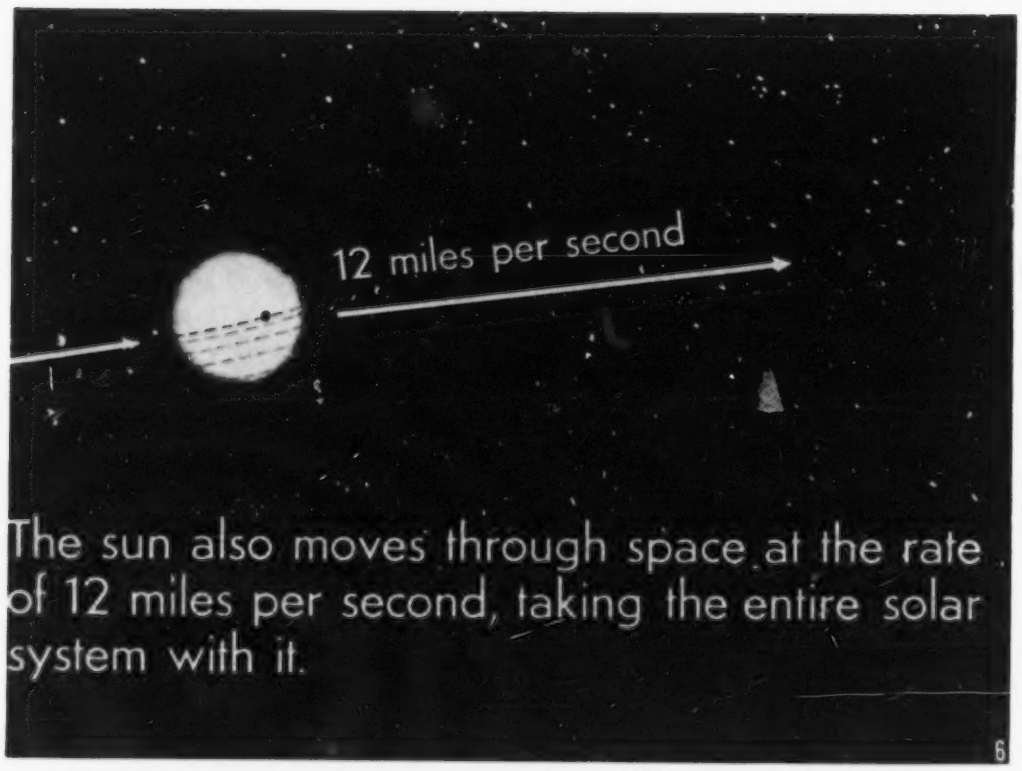

12 miles per second
The sun also moves through space at the rate of 12 miles per second, taking the entire solar system with it.
6

Figure 4B, Filmstrip Revision, Frame 6

Frame 8

The verbal element of the FSO reads as follows:

> There are nine known planets seen here compared in size against the disc of the sun. (See Figure 5A)

The pictorial element of the original does not show the entire disc of the sun, but merely a portion of the sun's disc.

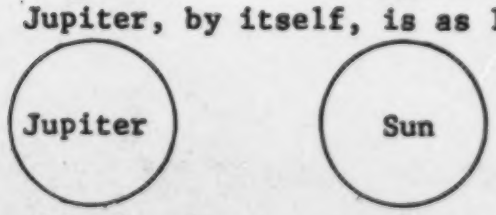
While each planet in the solar system is labeled, the sun itself carries no identifying caption to show that the large white area actually represents the sun. In the revision, the sun was labeled, and the edge of the sun was made more distinct. The caption was changed by adding the qualifying phrase, "a portion of".

To cover the concept of size in this frame, the following question was asked in the testing instrument:

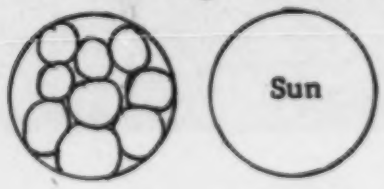
12. In comparing the sun to the planets in our solar system in <u>size</u>, which of the following is correct?

    1. some planets are larger than the sun

    2. Jupiter, by itself, is as large as the sun



    3. All the planets together are as large as the sun



    4. All the planets would fit in a small corner of the sun

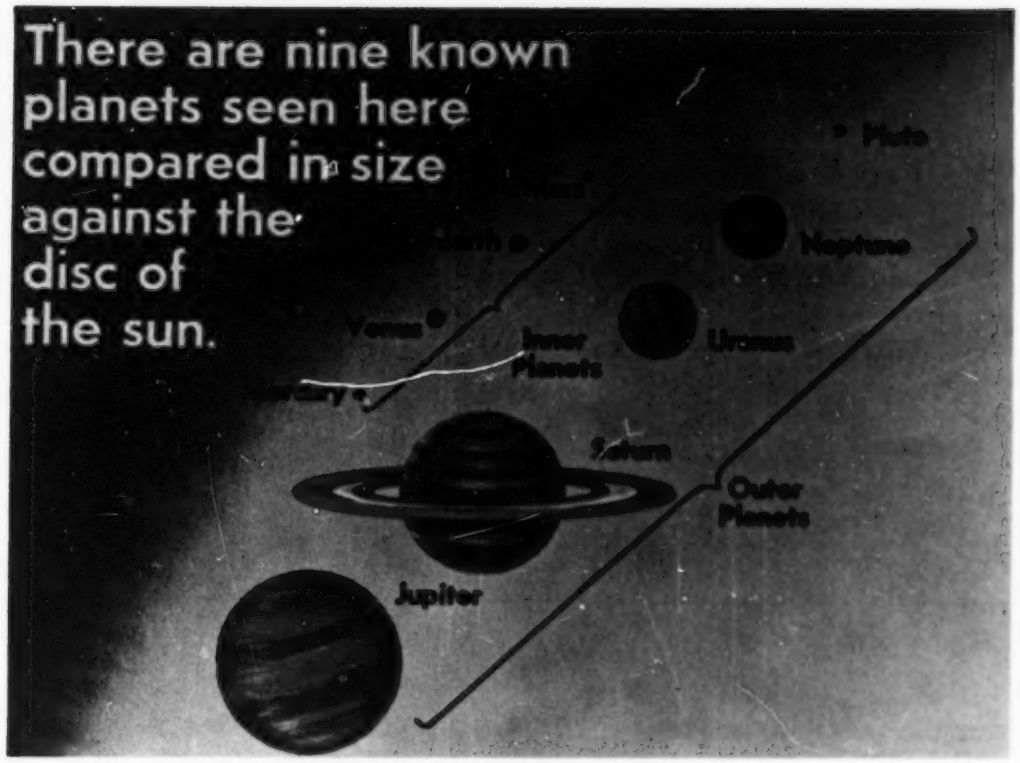


Figure 5A, Filmstrip Original, Frame 8

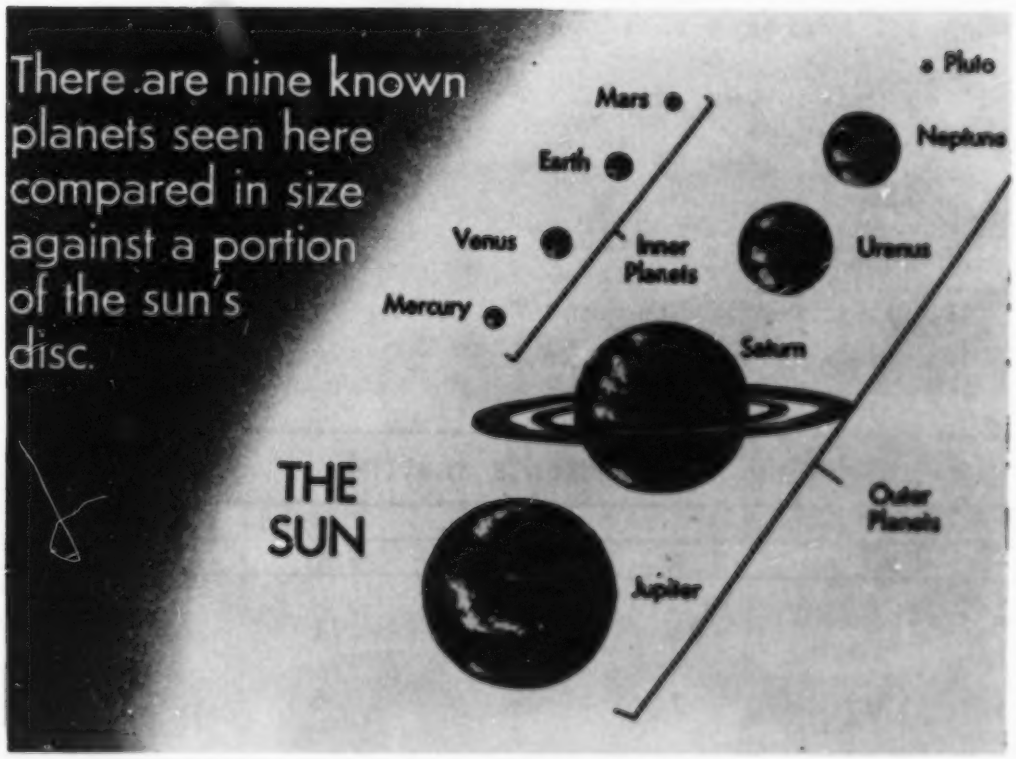


Figure 5B, Filmstrip Revision, Frame 8

TABLE IX

Proportion of Students Selecting Various Responses to Item 9

Item 9 - DELAYED TESTING						
	Grade 5		Grade 7		Grade 11	
	FSO	FSR	FSO	FSR	FSO	FSR
1. x	41	55	55	64	56	58
2.	20	15	16	15	19	17
3.	17	11	22	7	8	13
4.	19	17	5	13	18	12

As can be seen from Table IX, in all three grades a greater proportion of those seeing the revision responded correctly. The other three distractors attracted two out of five responses, however. An additional element may still be needed to reemphasize the sun's speed. Perhaps this could be done by changing "miles per second" to "miles per hour".

TABLE X

Proportions of Students Selecting Various Responses to Item 9

Item 9 - IMMEDIATE TESTING				
	Grade 8		Grade 11	
	FSO	FSR	FSO	FSR
1. x	100	86	71	97
2.	0	7	5	3
3.	0	5	14	0
4.	0	2	10	0

TABLE XI

Proportions of Students Selecting Various
Responses to Item 12

Item 12 - DELAYED TESTING						
	Grade 5		Grade 7		Grade 11	
	FSO	FSR	FSO	FSR	FSO	FSR
1.	13	3	3	8	7	12
2.	7	15	14	5	6	7
3.	16	25	23	17	18	11
4. x	64	55	59	69	69	70

TABLE XII

Proportions of Students Selecting Various
Responses to Item 12

Item 12 - IMMEDIATE TESTING				
	Grade 8		Grade 11	
	FSO	FSR	FSO	FSR
1.	25	15	12	10
2.	16	14	12	10
3.	21	20	29	10
4. x	39	51	45	69

Most of the groups seeing the revised frame did better than those who saw the original. Some did significantly better. It is surprising, however, that even under conditions of immediate testing nearly half the eighth graders and one-third of the eleventh graders who saw the revised version could not bring themselves to respond positively to that part of the test item that most nearly expresses the true relative size of the sun and its planets.

The situation was even worse with those who saw the original version, as in the earlier frame comparing the size of the earth with that of the sun, apparently comparatively tiny size of the earth is just too staggering for many of the unsophisticated to accept on the basis of the power of the communications medium employed in this filmstrip.

Frame 10

The verbal caption of Frame 10 was considered adequate by the investigators; however, since we habitually read from left to right, it was decided to move the sun from the lower right of the picture to the upper left, in the revision, and to distribute the planets along the line from left to right. Also, to reinforce the meaning of the mileage figures, the words "from the sun" were added to the labels near the symbols for the planets. In addition, the four inner planets were shown more clearly in the revision.

It was opined that the students would grasp the meaning of "480 million miles" more readily than "480,000,000 miles"; hence, the revised caption showed the former style.

The names of the planets were slightly increased in the revision, and the size of the planets was enlarged somewhat so that the sides could more adequately show the reflected light of the sun. Since the planets are pictured against a black background, the high-lighting technique tends to give a more realistic setting. The test items on this frame were:

16. The five planets farthest from the sun are called the <u>outer planets</u>. By name we call these planets:

    1. Saturn, Uranus, Neptune, Pluto, Mars
    2. Earth, Jupiter, Uranus, Neptune, Pluto
    3. Jupiter, Saturn, Uranus, Neptune, Pluto
    4. Neptune, Uranus, Saturn, Jupiter, Earth

17. In distance from the sun, the outer planets range from:

    1. 80 to 210 million miles
    2. 450 to 900 million miles
    3. 480 to 3,665 million miles
    4. 540 to 7,671 million miles

TABLE XIII

Proportions of Students Selecting Various Responses to Items 16 and 17

Item 16 - DELAYED TESTING

	Grade 5		Grade 7		Grade 11	
	FSO	FSR	FSO	FSR	FSO	FSR
1.	17	19	7	7	6	6
2.	13	9	4	2	1	4
3. x	58	62	84	86	87	83
4.	14	10	4	4	5	7

Item 17 - DELAYED TESTING

	Grade 5		Grade 7		Grade 11	
	FSO	FSR	FSO	FSR	FSO	FSR
1.	17	7	15	8	7	5
2.	18	17	14	11	16	21
3. x	33	38	54	68	64	57
4.	32	36	37	33	32	36

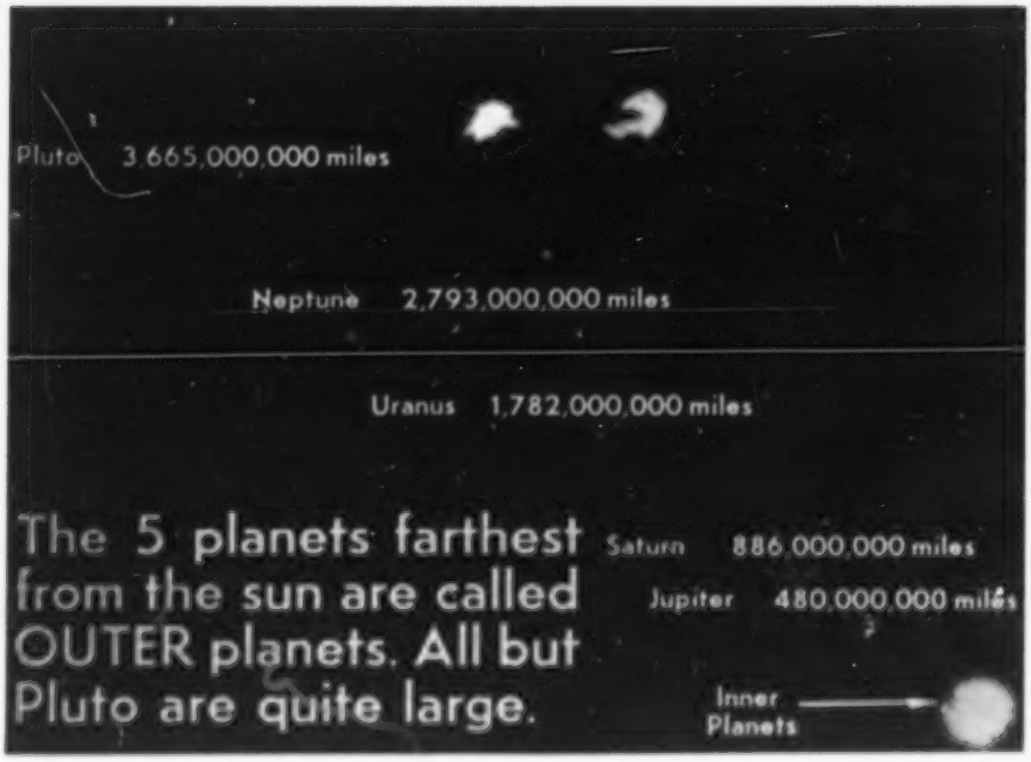

Pluto 3,665,000,000 miles
Neptune 2,793,000,000 miles
Uranus 1,782,000,000 miles
The 5 planets farthest from the sun are called OUTER planets. All but Pluto are quite large.
Saturn 886,000,000 miles
Jupiter 480,000,000 miles
Inner Planets

Figure 6A, Filmstrip Original, Frame 10

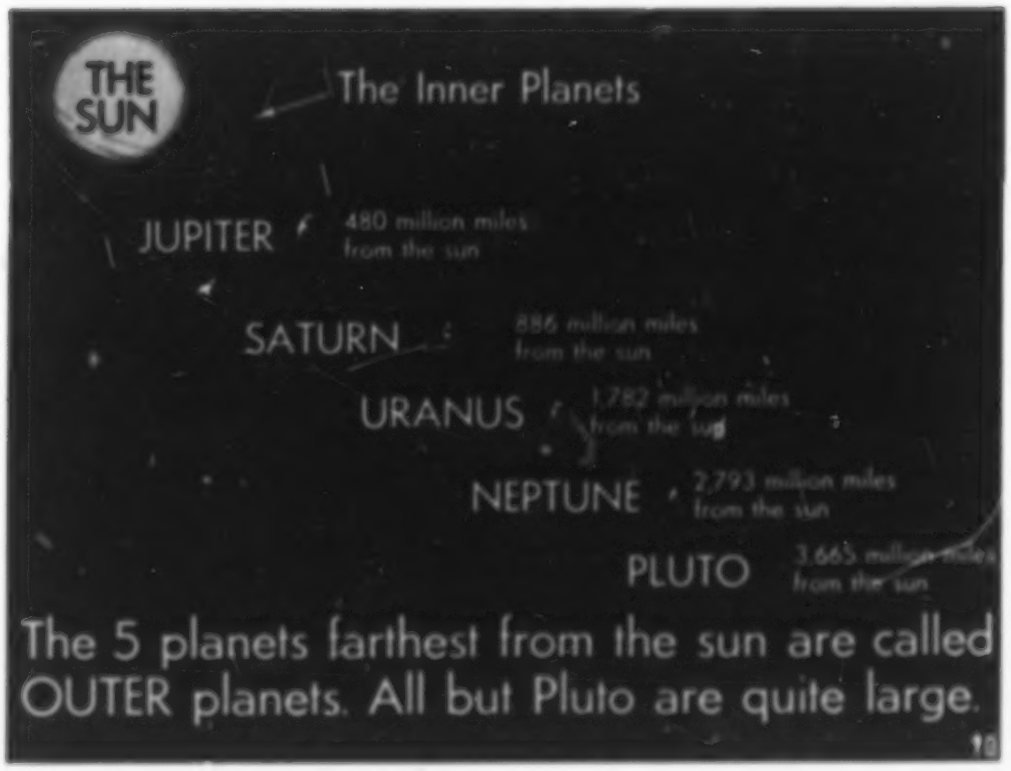

THE SUN
The Inner Planets
JUPITER
480 million miles from the sun
SATURN
886 million miles from the sun
URANUS
1,782 million miles from the sun
NEPTUNE
2,793 million miles from the sun
PLUTO
3,665 million miles from the sun
The 5 planets farthest from the sun are called OUTER planets. All but Pluto are quite large.
10

Figure 6B, Filmstrip Revision, Frame 10

TABLE XIV

Proportions of Students Selecting Various Responses to Items 16 and 17

Item 16 - IMMEDIATE TESTING

	Grade 8		Grade 11	
	FSO	FSR	FSO	FSR
1.	12	7	2	0
2.	4	5	2	3
3. x	75	88	93	95
4.	9	0	2	3

Item 17 - IMMEDIATE TESTING

	Grade 8		Grade 11	
	FSO	FSR	FSO	FSR
1.	5	3	0	3
2.	4	8	12	0
3. x	75	68	79	92
4.	18	19	10	5

The revision generally elicited a greater proportion of correct responses, but the difference was seldom statistically significant. The most favored distractor was the one that tended to overestimate the distance between the sun and the most remote planet. This may be consistent with the tendency to overestimate the size of the planets.

Frame 11

In the original filmstrip the planets were represented by somewhat iconic symbols, arranged in the frame in no discernable order. It was hypothesized that the relative sizes of the planets would be more readily apparent if the symbols were arranged according to size and if a scale were included against which to judge relative sizes. Furthermore, in interviews students in the eleventh grade told the investigator that they thought Saturn was the largest planet because the rings made it look much larger than Jupiter. It was thought that by removing the rings of Saturn and by reducing iconicity by representing all the planets by circles from the smallest to the largest, the students would be given an overall picture of how the planets relate to each other in size. The frame was graduated on the left side and along the bottom with each space representing 3,000 miles. (See Figure 7B)

The following two items were listed on the testing instrument:

18. The <u>largest</u> of the outer planets is called:

    1. Saturn
    2. Jupiter
    3. Neptune
    4. Uranus

19. The largest planets in our solar system are:

    1. Neptune, Jupiter
    2. Saturn, Pluto
    3. Uranus, Neptune
    4. Jupiter, Saturn

TABLE XV

Proportions of Students Selecting Various Responses to Items 18 and 19

Item 18 - DELAYED TESTING

	Grade 5		Grade 7		Grade 11	
	FSO	FSR	FSO	FSR	FSO	FSR
1.	23	17	16	20	18	15
2. x	63	65	73	64	71	72
3.	10	8	6	9	6	7
4.	5	10	4	7	5	6

Item 19 - DELAYED TESTING

	Grade 5		Grade 7		Grade 11	
	FSO	FSR	FSO	FSR	FSO	FSR
1.	19	26	15	23	18	13
2.	7	4	3	1	4	4
3.	14	11	10	8	2	10
4. x	58	57	72	67	76	73

Figure 7A, Filmstrip Original, Frame 11

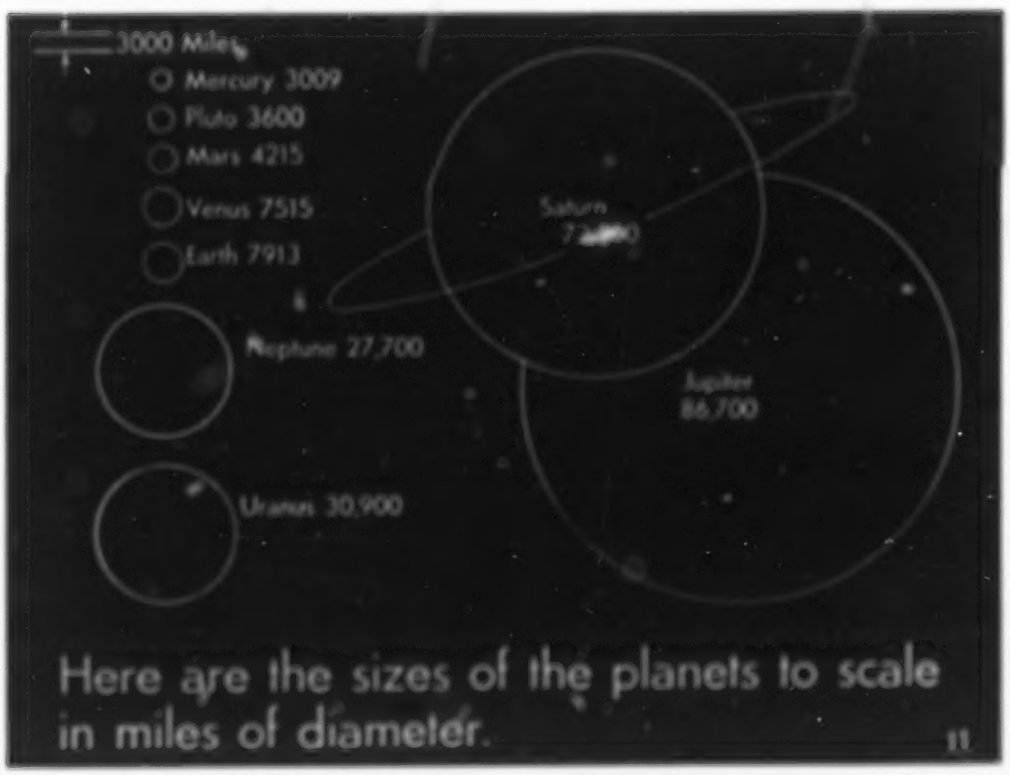


Figure 7B, Filmstrip Revision, Frame 11

TABLE XVI

Proportions of Students Selecting Various Responses to Items 18 and 19

Item 18 - IMMEDIATE TESTING

	Grade 8		Grade 11	
	FSO	FSR	FSO	FSR
1.	25	12	19	10
2. x	60	80	76	82
3.	12	2	5	3
4.	4	7	0	5

Item 19 - IMMEDIATE TESTING

	Grade 8		Grade 11	
	FSO	FSR	FSO	FSR
1.	19	5	7	18
2.	4	3	5	3
3.	4	10	2	5
4. x	74	80	86	74

If the revision reduced the incidence of the error of considering Saturn to be the largest planet, it was ineffectual in teaching consistently what were the largest planets. The reduction in iconicity seemingly "paid off" in reducing a specific error, but the errors then became more general rather than transferring to correct responses. The hypotheses tested in the revision, though seemingly promising, failed to gain support from the data.

Frame 15

In changing this frame the sun was moved to the upper left hand corner so the students could read the planets from left to right in the same order as they appear in the heavens in distance from the sun. The caption was moved to the bottom of the frame. Planet titles were enlarged slightly and information on time and speed was rearranged for what was hoped would be easier reading. (See Figure 8A and 8B)

The following item was intended to sample learning from this frame:

23. The outer planets have longer years because they:

1. are so far from the sun
2. travel very slowly
3. have longer orbits
4. all of these

TABLE XVII

Proportions of Students Selecting Various Responses to Item 23

Item 23 - DELAYED TESTING						
	Grade 5		Grade 7		Grade 11	
	FSO	FSR	FSO	FSR	FSO	FSR
1.	27	37	15	21	8	4
2.	13	9	7	5	3	8
3.	33	29	34	29	32	28
4. x	27	24	44	44	56	60

TABLE XVIII

Proportions of Students Selecting Various Responses to Item 23

Item 23 - IMMEDIATE TESTING				
	Grade 5		Grade 11	
	FSO	FSR	FSO	FSR
1.	2	7	0	3
2.	16	5	14	0
3.	26	19	12	13
4. x	56	69	74	85

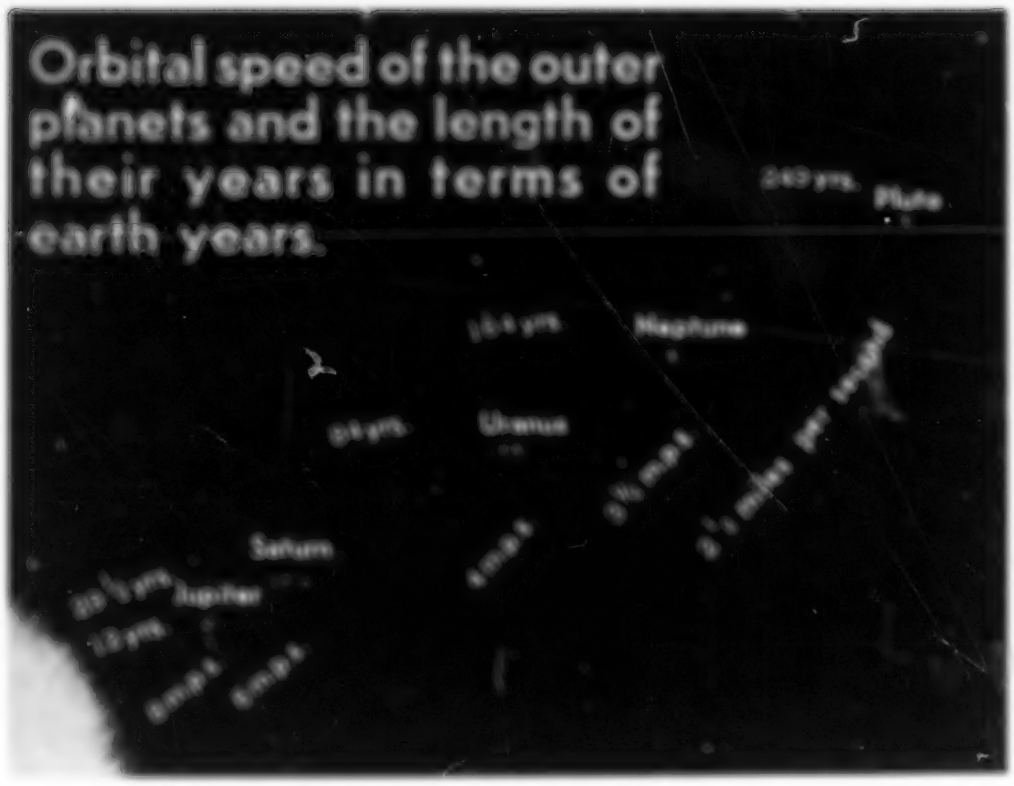


Figure 8A. Filmstrip Original, Frame 1)

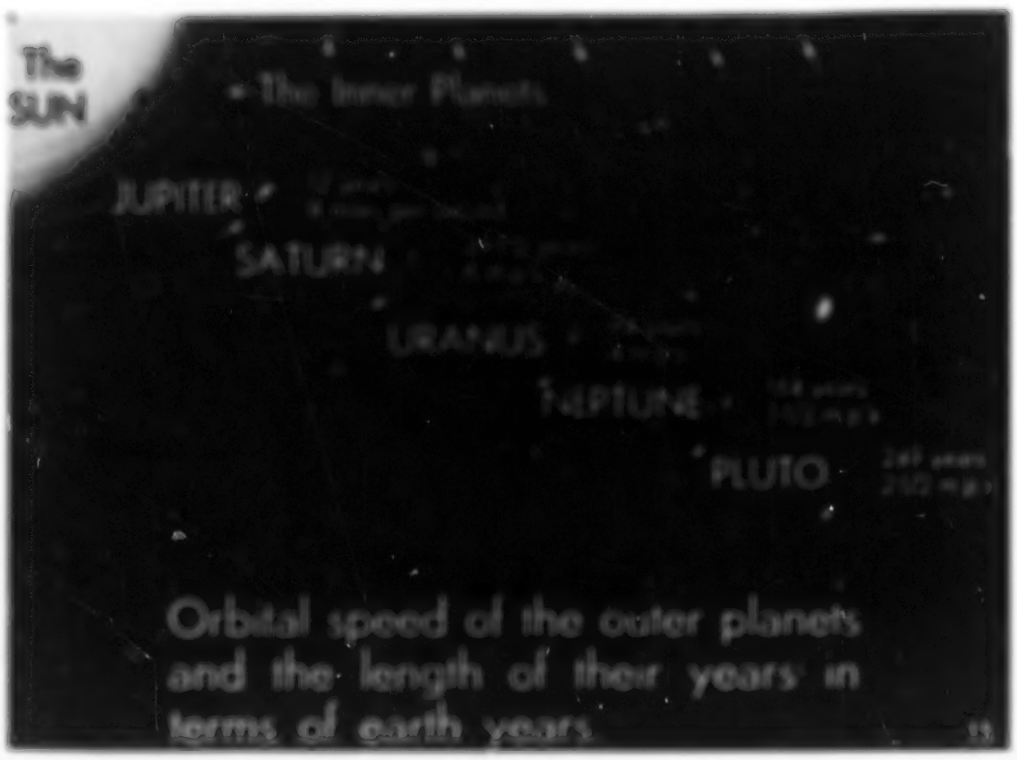


Figure 8B. Filmstrip Revision, Frame 15

The revision appears to have produced somewhat better results than the original, though not significantly so. It is perhaps not surprising that alternative number two did not appear attractive to a high proportion of respondants in view of the fact that it would require a positive response to the nation that a speed of four miles per second is slow. It might well be hypothesized that the revision would have been more successful than the original in teaching the order of progression of orbital periods and orbital speeds, but this, unfortunately, was not tested. It might also be hypothesized that a table or a graph would be superior to the diagram is teaching this concept. This hypothesis was tested in a similar context in the next frame.

The caption on the original frame 17 contained a mild contradiction in that it stated that the direction of rotation of all planets except Uranus is counter-clockwise, whereas the fact is that the pictorial part of the frame indicates that the direction of rotation of Venus and Pluto is not known. Besides correcting the caption, the diagram of the original was replaced by a table in the revised version.

The following test item related to Frame 17:

25. Not all the rotation periods of the planets are known. Which two are unknown?

    1. Mercury and Uranus
    2. Venus and Pluto
    3. Jupiter and Saturn
    4. Neptune and Mars

The results in terms of responses to the test item indicate that, if anything, the revision was worse than the original. Actually, the proportion of correct responses was rather high for both versions; namely, from 80 to 90 per cent.

TABLE XIX

Proportions of Students Selecting Various
Responses to Item 25

Item 25 - DELAYED TESTING

	Grade 5		Grade 7		Grade 11	
	FSO	FSR	FSO	FSR	FSO	FSR
1.	8	12	3	9	13	16
2.	82	79	90	80	81	74
3.	3	7	3	4	4	8
4.	7	2	3	6	2	2

Correct Answer No. 2

TABLE XX

Proportions of Students Selecting Various
Responses to Item 25

Item 25 - IMMEDIATE TESTING

	Grade 8		Grade 11	
	FSO	FSR	FSO	FSR
1.	12	7	5	10
2.	84	88	90	82
3.	0	2	0	0
4.	2	3	5	8

Correct Answer No. 2

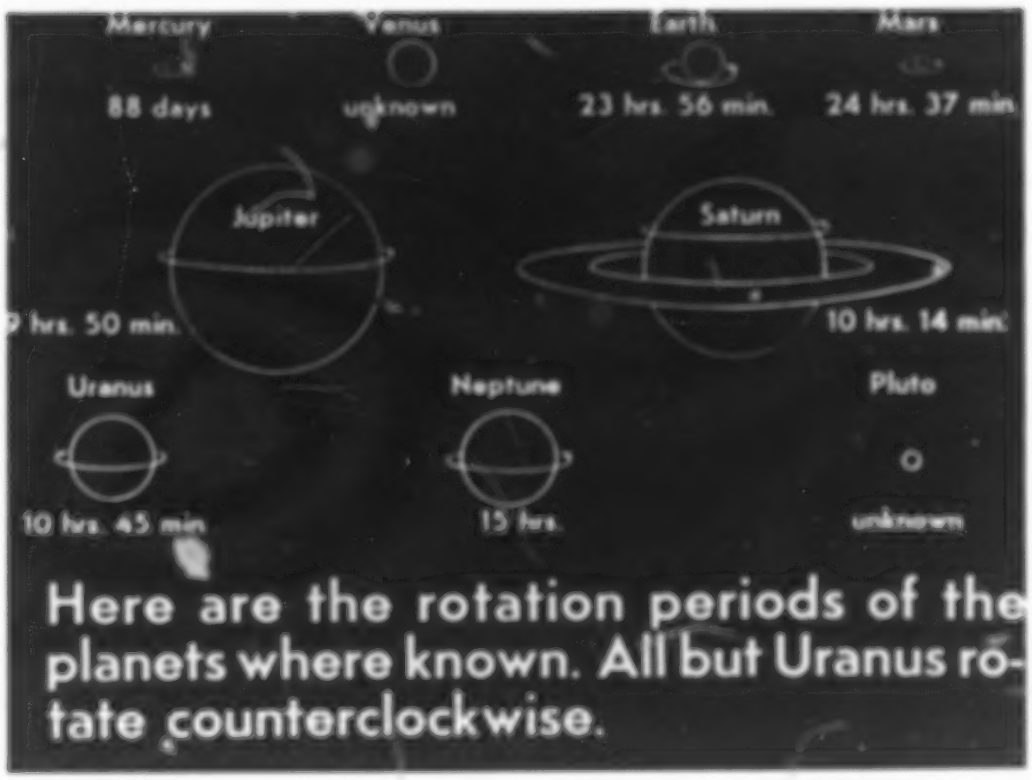


Figure 9A, Filmstrip Original, Frame 17

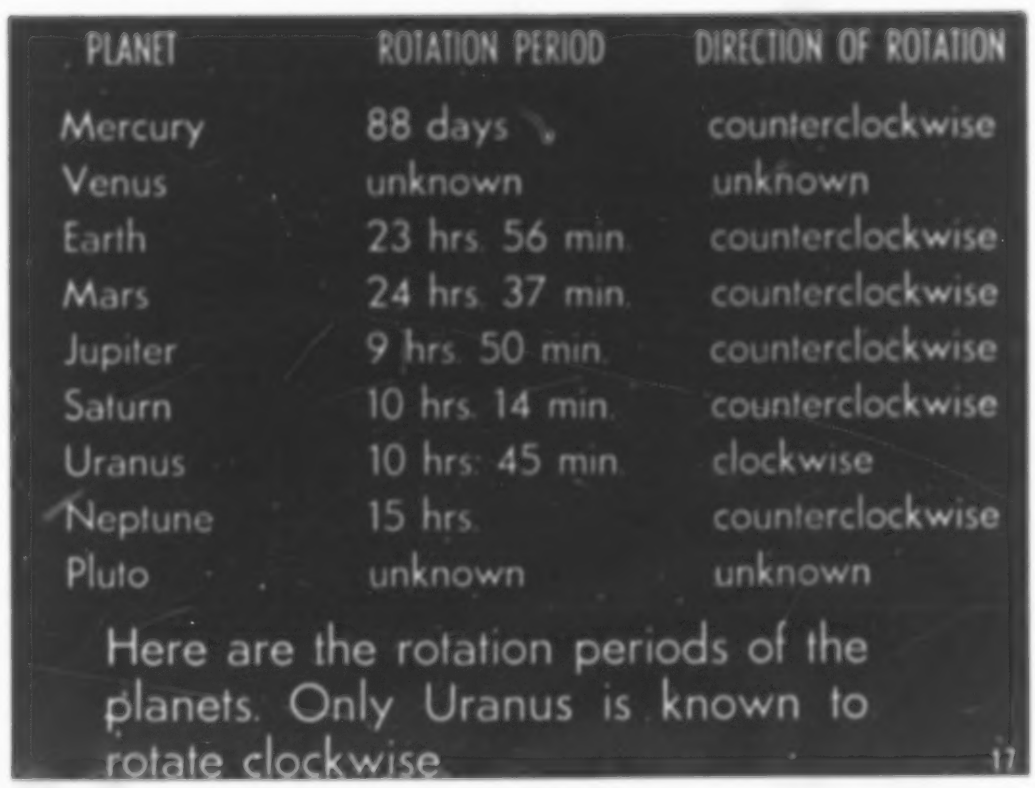


Figure 9B, Filmstrip Revision, Frame 17

Frame 21

Frame 21 was revised by presenting the information in a split drawing (See Figure 10B), showing the same concept as shown in the original. Also, added to the caption was the statement, "we are facing south". In addition, directional clues were given in the pictorial elemenc by adding the word "south" to the pictorial element.

The following item was included in the testing instrument on Frame 21:

29. When "West" of the sun, Mercury and Venus rise before the sun and are seen as:

    1. evening "stars"
    2. moons
    3. morning "stars"
    4. comets

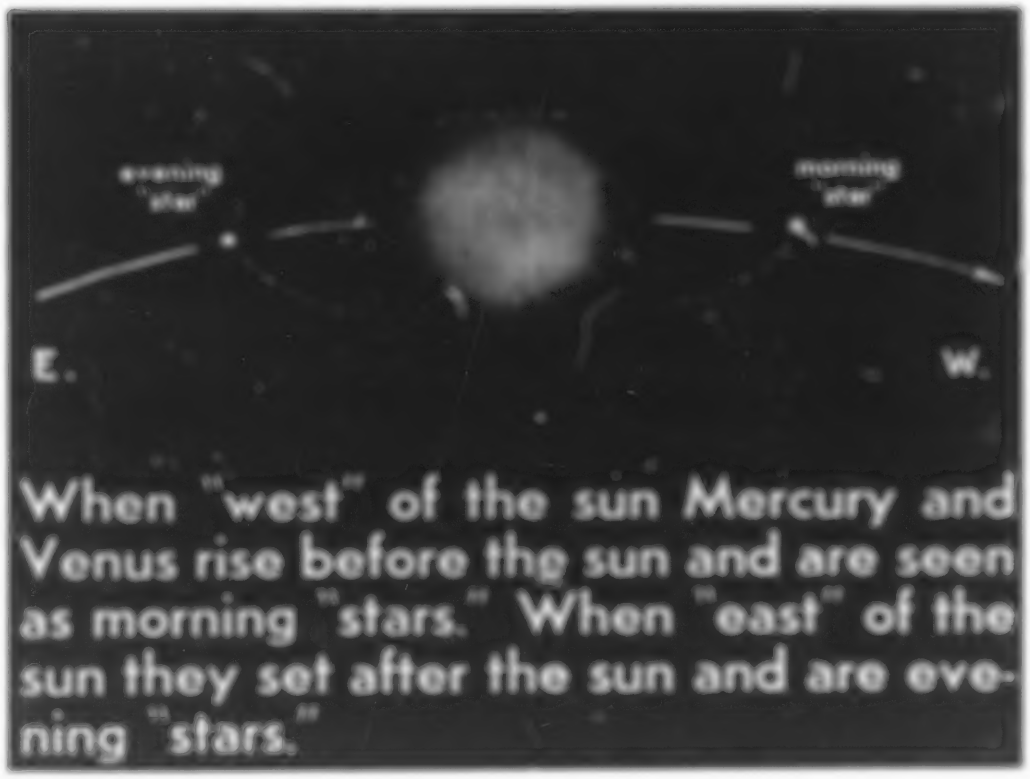

E.
W.
When "west" of the sun Mercury and Venus rise before the sun and are seen as morning "stars." When "east" of the sun they set after the sun and are evening "stars."

Figure 10A. Filmstrip Original, Frame 21

Morning star rising in the east just before sunrise
Evening star appears in west just after sunset
SUN
SUN
East
West
South
East
West
South
The dotted lines are the orbits of Venus. When "east" of the sun, Venus is an evening star, and vice versa. Mercury behaves the same way. In this picture, we are facing south.
21

Figure 10B. Filmstrip Revision, Frame 21

TABLE XXI

Proportions of Students Selecting Various
Responses to Item 29

Item 29 - DELAYED TESTING						
	Grade 5		Grade 7		Grade 11	
	FSO	FSR	FSO	FSR	FSO	FSR
1.	40	36	33	48	31	28
2.	5	7	4	6	2	4
3. x	45	48	56	44	65	64
4.	9	7	2	2	3	4

TABLE XXII

Proportions of Students Selecting Various
Responses to Item 29

Item 29 - IMMEDIATE TESTING				
	Grade 8		Grade 11	
	FSO	FSR	FSO	FSR
1.	32	46	14	51(1)
2.	0	3	0	0
3. x	68	51	86	46(1)
4.	0	0	0	3

The responses from the students indicate that the FSO seemed to communicate with the students better than did the revision. The grade eleven students taking the immediate testing instrument on the FSO did significantly better, as did the eighth grade students.

It would appear that the concept to be taught by this frame requires students to visualize in three dimensions. A model might be required in this situation. Alternatively, it might be better to show a top view of this frame to get the concept across.

Frame 24

The picture in the upper right of the original frame was intended to show what the boy in the picture sees when he looks through the telescope. Since the field of a telescope is round instead of rectangular, the appropriate shape was used in the revision. Also, the drawing of a planet was placed at the end of the telescope to indicate that this was the planet the boys at the telescope were seeing. Finally, the image was made to appear brighter.

The original caption, "How does a telescope show the planets?" was changed to read, "How do planets look through a telescope?"

How does a telescope show the planets?
A telescope is necessary to brighten and magnify planet images to show them as they really are.

Figure 11A, Filmstrip Original, Frame 24

How do planets look through a telescope?
A telescope is necessary to brighten and magnify planet images to show them as they really are.
24

Figure 11B, Filmstrip Revision, Frame 24

The following item was included in the testing instrument:

22. To study the stars, a telescope may be used to:

    1. brighten the planet images
    2. magnify the planets
    3. see them as they really are
    4. all of these

TABLE XXIII

Proportions of Students Selecting Various
Responses to Item 32

Item 32 - DELAYED TESTING						
	Grade 5		Grade 7		Grade 11	
	FSO	FSR	FSO	FSR	FSO	FSR
1.	9	12	9	14	8	4
2.	20	21	23	27	40	32
3.	34	39	24	27	13	13
4. x	33	25	44	32	35	51

TABLE XXIV

Proportions of Students Selecting Various
Responses to Item 32

Item 32 - IMMEDIATE TESTING				
	Grade 8		Grade 11	
	FSO	FSR	FSO	FSR
1.	23	14	10	5
2.	23	7	5	5
3.	19	20	24	10
4. x	35	59	62	80

A significantly greater proportion of students who saw the revised version responded correctly to this item. Which changes contributed to the improvement is not known.

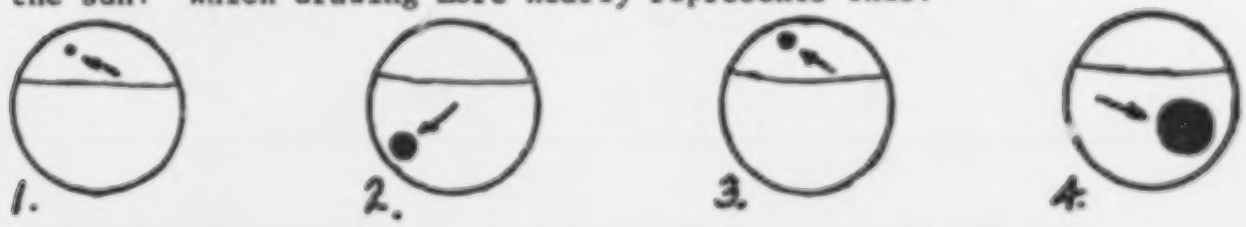
Frame 25

This frame, consisting of an authentic telephotograph, in the FSO had a dark line cutting through the sun. No one seemed to know why this line existed, so it was removed in the revision. The small dot near the top of the sun was pointed out by an arrow but was not labeled. (See Figure 12A). Other spots appeared on the face of the sun and were not labeled in the original. In the FSR, Mercury was labeled along with the sunspots (See Figure 12B). It was also attempted to make the sun look more realistic in the revision.

The caption was also modified by eliminating the phrase, "Transit of Mercury", which it was hypothesized added nothing to the concept in the frame and might be distracting. Also, it was hoped that students would be impressed and learn more if they knew they were seeing a real telephotograph.

The test item consisted of four drawings showing four different "sizes of Mercury" against the sun's disc. The students were asked to select the one that showed Mercury as most nearly the right size. The results are summarized in Tables XXV and XXVI.

33. From earth we can see Mercury as it passes across the face of the sun. Which drawing more nearly represents this:



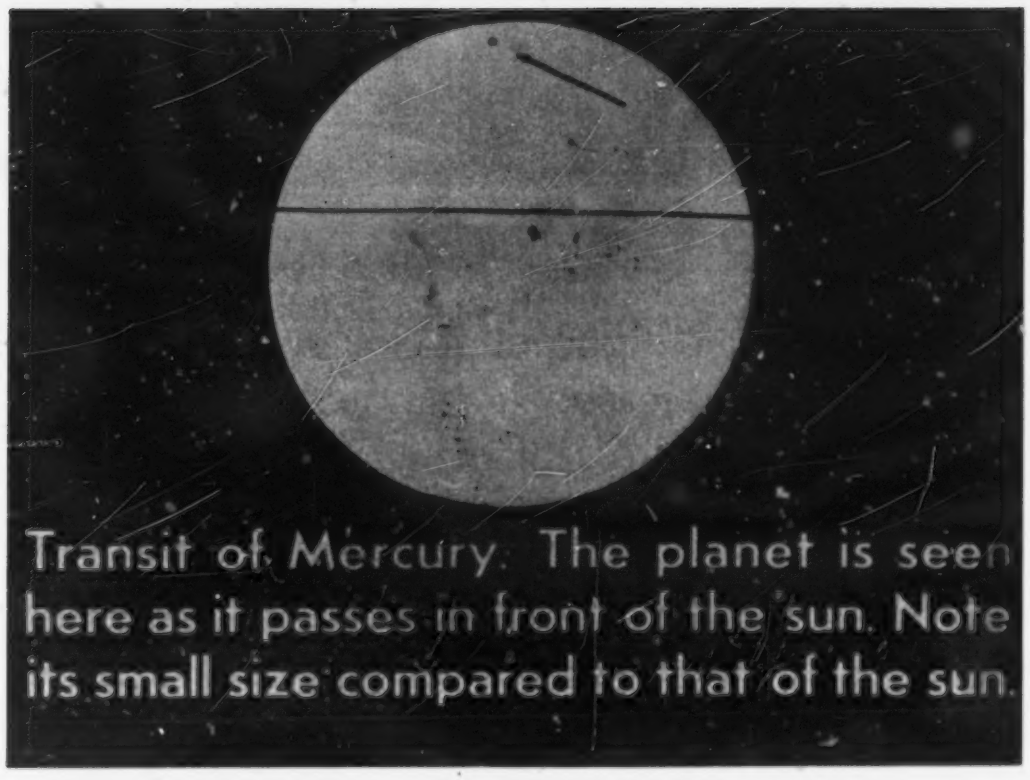


Figure 12A, Filmstrip Original, Frame 25

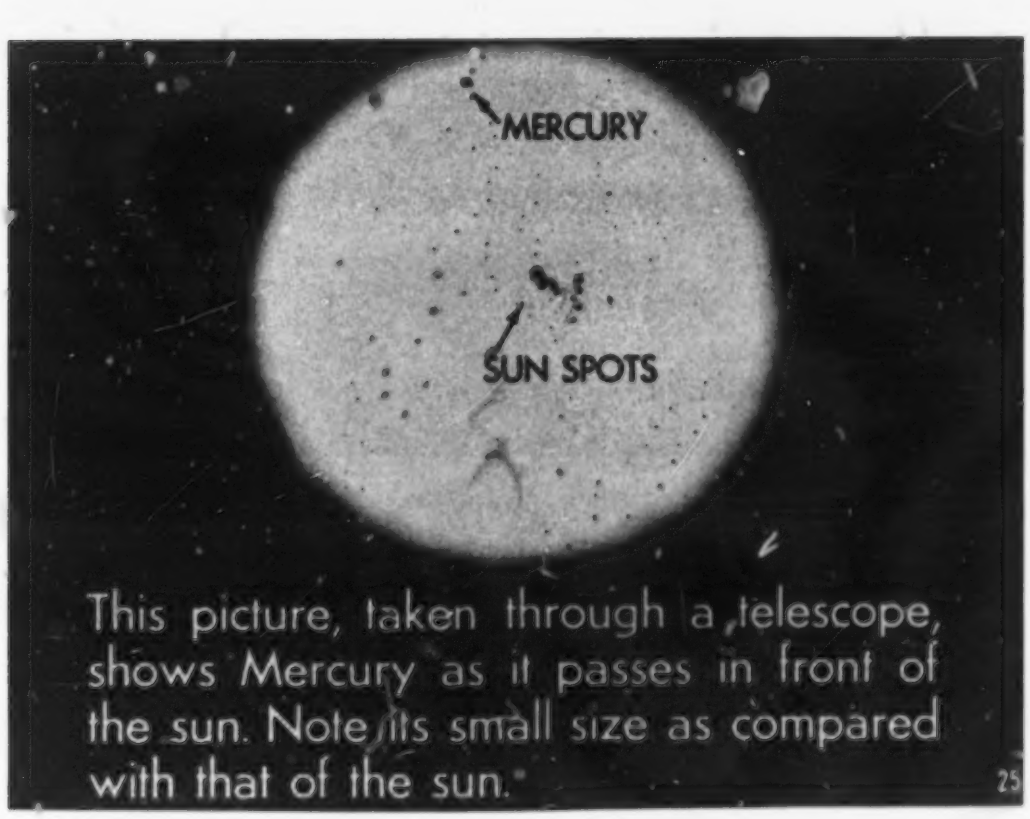

MERCURY
SUN SPOTS
This picture, taken through a telescope, shows Mercury as it passes in front of the sun. Note its small size as compared with that of the sun.
25

Figure 12B, Filmstrip Revision, Frame 25

TABLE XXV

Proportions of Students Selecting Various
Responses to Item 33

Item 33 - DELAYED TESTING						
	Grade 5		Grade 7		Grade 11	
	FSO	FSR	FSO	FSR	FSO	FSR
1. x	48	55	61	65	71	76
2.	8	8	11	7	10	4
3.	20	16	18	22	13	11
4.	18	18	11	5	6	9

TABLE XXVI

Proportions of Students Selecting Various
Responses to Item 33

Item 33 - IMMEDIATE TESTING				
	Grade 8		Grade 11	
	FSO	FSR	FSO	FSR
1. x	83	77	77	75
2.	2	8	9	5
3.	12	15	5	12
4.	2	0	9	8

The results of the revision are inexplicably unsupporting to the revision. Perhaps the sunspots should have been removed, or perhaps they should have been used in the caption as further referents for size comparisons.

Frame 26

It was the judgment of the investigators that in revising this frame an improvement could be made by adding a view of Earth, Venus, and Mercury circling the sun. The purpose of the frame is to explain why it is that Venus and Mercury show phases like our moon. (See Figures 13A and 13B).

The four pictures of the phases of Venus were reduced in size and labeled, "Venus as seen with a telescope".

It should be added that the caption in the original is not strictly correct in that most of the time Venus is not between the earth and the sun; in fact, it is as frequently on the other side of the sun as it is between earth and the sun. The same, of course, is true for Mercury; i.e., the sun is frequently between the earth and Mercury or Venus. This error was corrected in the revision by making the caption say that Venus and Mercury are closer to the sun than the earth is, which is strictly correct.

The following question was listed on the testing instrument to test whether they could recall the reason why Mercury and Venus show phases like our moon:

34. Mercury, like Venus, shows phases like our moon. The reason for this is because the positions of the earth, sun, and Mercury are like one of the figures shown below. Which one:

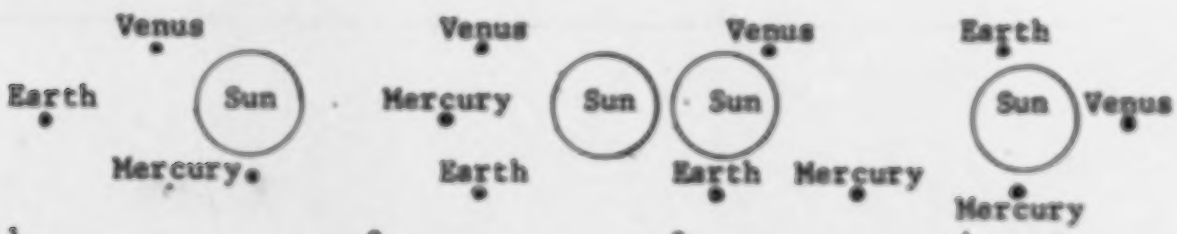


TABLE XXVII

Proportions of Students Selecting Various Responses to Item 34

Item 34 - DELAYED TESTING						
	Grade 5		Grade 7		Grade 11	
	FSO	FSR	FSO	FSR	FSO	FSR
1. x	16	22	18	29	28	28
2.	25	21	22	25	21	21
3. x	25	28	31	15	22	23
4.	30	24	26	27	29	26
1. and 3.	41	50	49	44	50	51

TABLE XXVIII

Proportions of Students Selecting Various Responses to Item 34

Item 34 - IMMEDIATE TESTING				
	Grade 8		Grade 11	
	FSO	FSR	FSO	FSR
1. x	37	34	45	67
2.	12	20	24	10
3. x	18	27	12	0
4.	32	19	19	21
1. and 3.	55	61	57	67

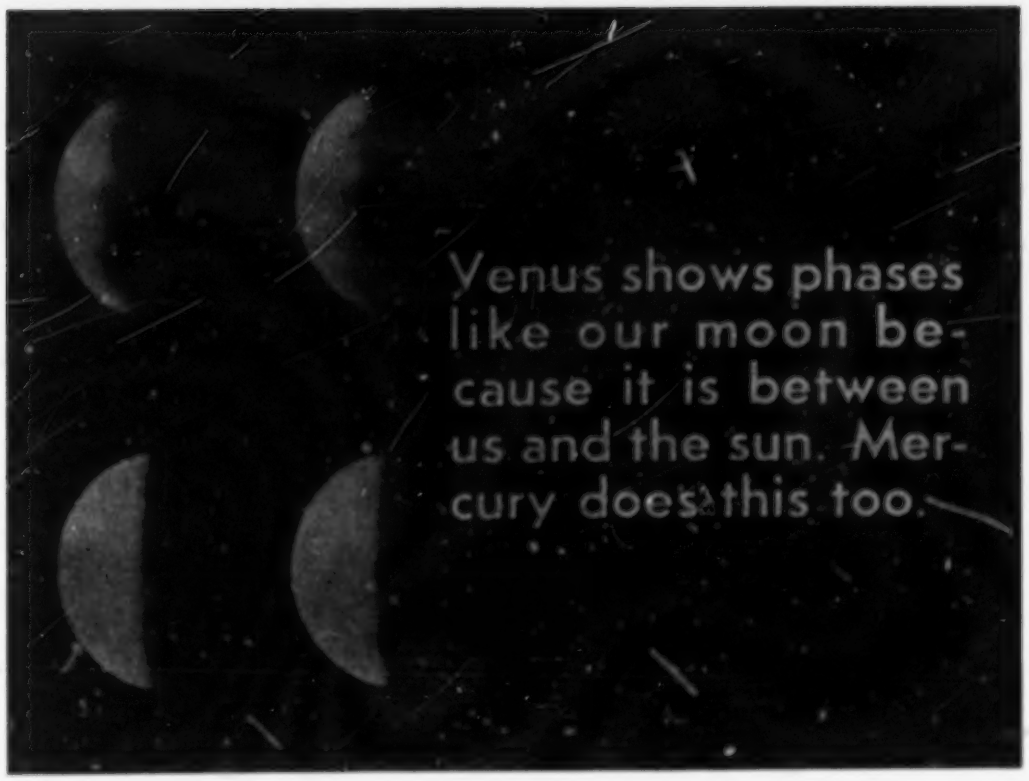


Figure 13A, Filmstrip Original, Frame 26

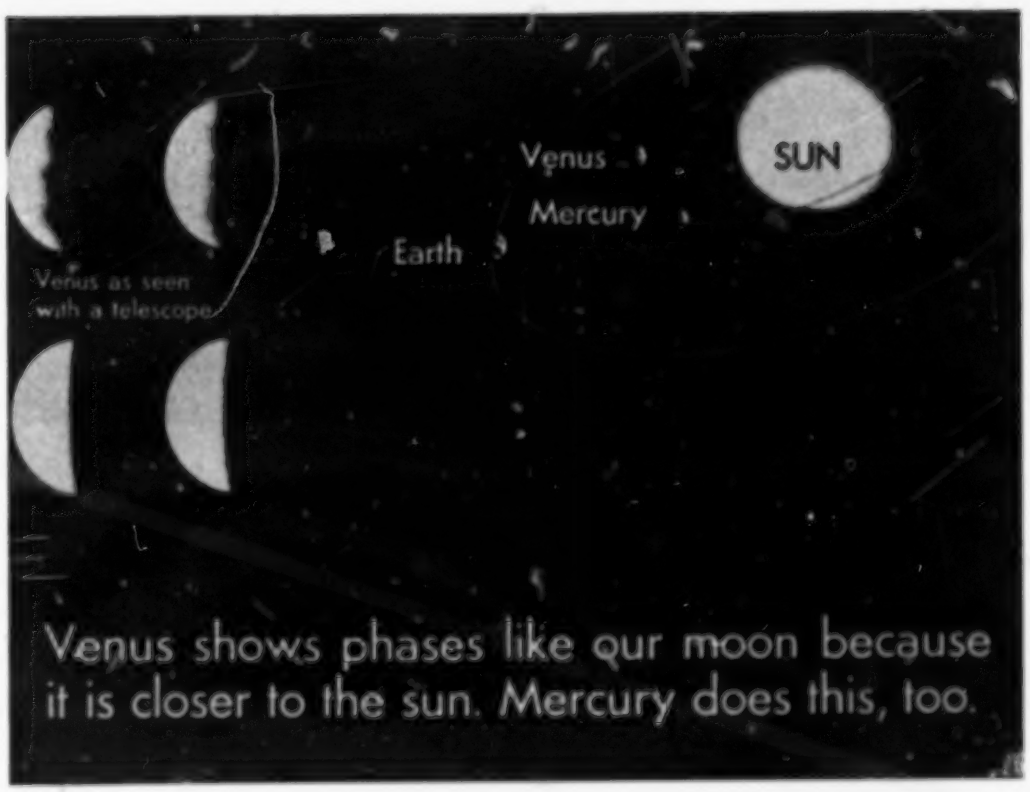

Venus
Mercury
Earth
SUN
Venus as seen with a telescope
Venus shows phases like our moon because it is closer to the sun. Mercury does this, too.

Figure 13B, Filmstrip Revision, Frame 26

Interviews with students showed that there were good grounds for considering both choices (1) and (3) correct, although, strictly speaking, Venus could not show phases in the position in its orbit indicated in choice (3). Either system of scoring shows small but fairly consistent results in favor of the revision, although on delayed testing and even on immediate testing in grade eight the responses so nearly assumed a random pattern that it can hardly be said that learning occurred from either the original or the revised filmstrip frames. On the other hand, two out of three eleventh graders chose the most clearly correct response.

Frame 34

Frame 34 was revised to make it easier for the students to identify Venus in the picture. A label was added and the drawing of Venus was made brighter; that is, more "contrasty".

In the revised filmstrip, the landscape was changed to suggest the sun setting in the west at the time Venus is seen. This is another clue that Venus is being shown, because Venus is referred to elsewhere in the filmstrip as an evening star.

The caption was also changed in the revision. The astronomer's symbol for Venus was removed, and the construction was changed. The revised caption connected the cloud cover of Venus with both its brilliance and the mystery of its surface.

The following item was included in the testing instrument:

42. Venus is completely covered by clouds, so very little is known about it. We do know that it is:

    1. the smallest planet in our solar system
    2. the fastest moving planet of the inner planets
    3. larger than our earth
    4. the brightest of the planets

TABLE XXIX

Proportions of Students Selecting Various
Responses to Item 42

Item 42 - DELAYED TESTING						
	Grade 5		Grade 7		Grade 11	
	FSO	FSR	FSO	FSR	FSO	FSR
1.	13	15	10	13	10	20
2.	22	22	9	20	12	27
3.	18	21	21	13	17	13
4. x	43	37	59	54	61	40 (.01)

TABLE XXX

Proportions of Students Selecting Various
Responses to Item 42

Item 42 - IMMEDIATE TESTING				
	Grade 8		Grade 11	
	FSO	FSR	FSO	FSR
1.	4	5	5	3
2.	5	10	0	5
3.	5	10	2	10
4. x	86	75	93	82

From the item analysis on this question it is evident that the FSO was superior on all grade levels. It may be that the changed caption with its more complex construction and its elimination of the powerful adjective "brilliantly" more than undid whatever improvements may have been made in revising the pictorial part of the frame.

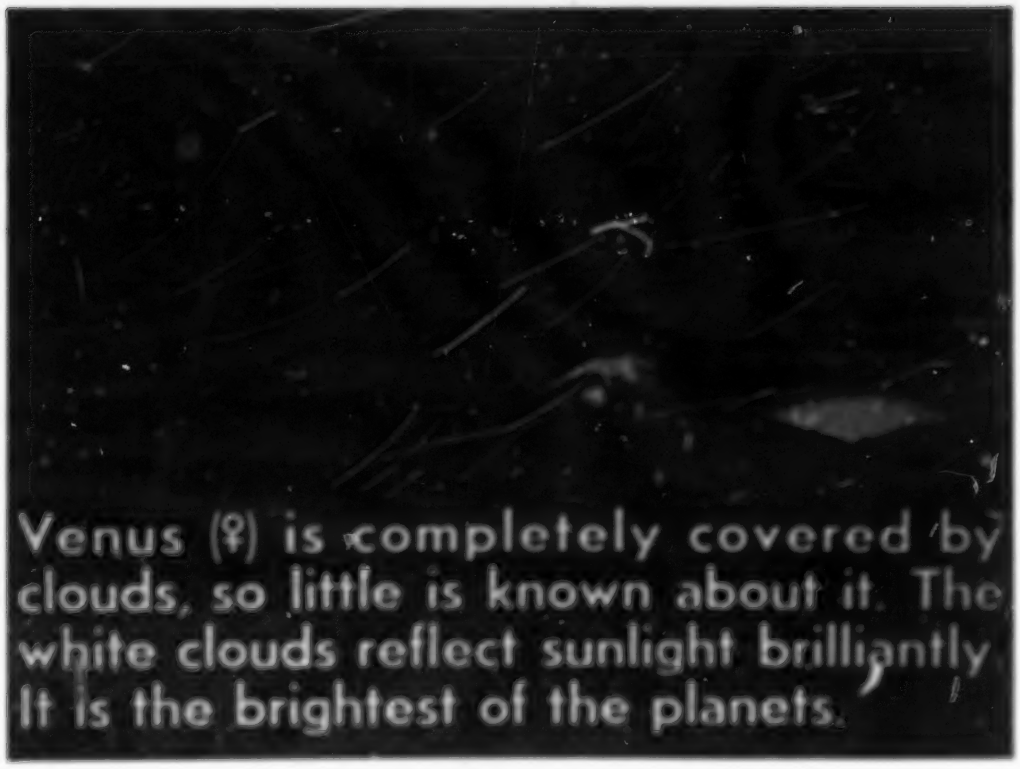

Venus (♀) is completely covered by clouds, so little is known about it. The white clouds reflect sunlight brilliantly. It is the brightest of the planets.

Figure 14A, Filmstrip Original, Frame 34

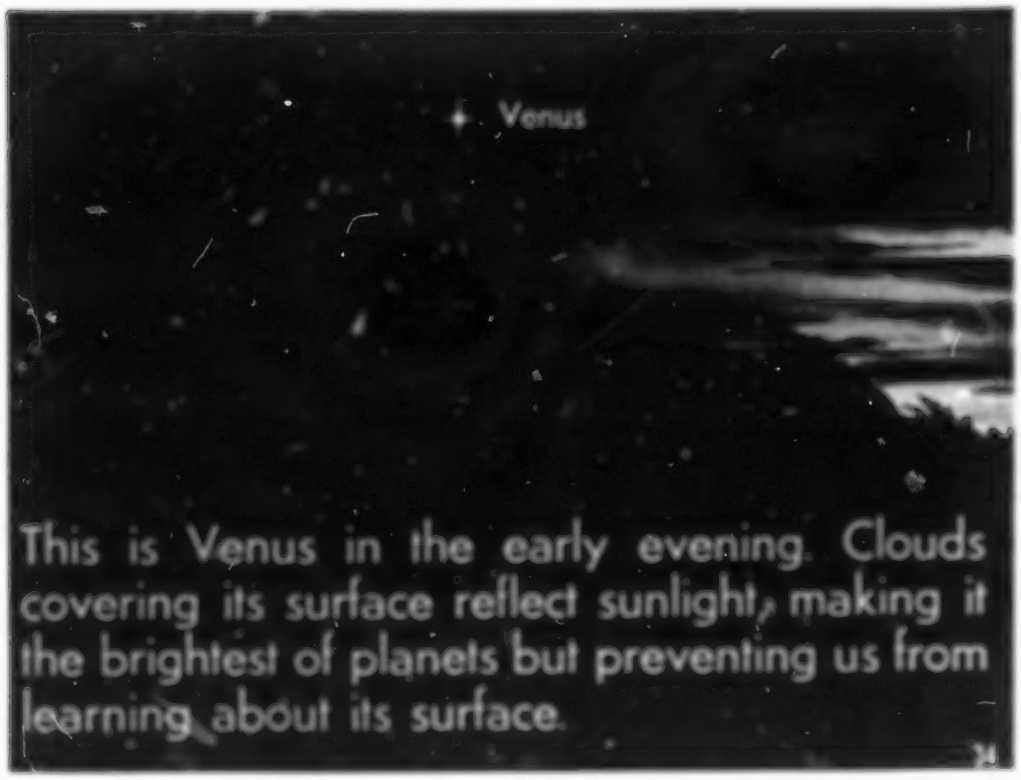

Venus
This is Venus in the early evening. Clouds covering its surface reflect sunlight, making it the brightest of planets but preventing us from learning about its surface.
34

Figure 14B, Filmstrip Revision, Frame 34

Frame 40

In the original filmstrip Frame 40 is a duplication of Frame 32 and depends entirely on the caption for any factual information. (See Figure 15A). In the revision, the frame was designed to show how the sun might possibly look from Pluto, rather than to show the appearance of Pluto from the earth. The caption followed the pattern of the original in that it emphasized that Pluto would be cold and dark. The picture also included white areas in order to suggest the idea that it would be cold. (See Figure 15B).

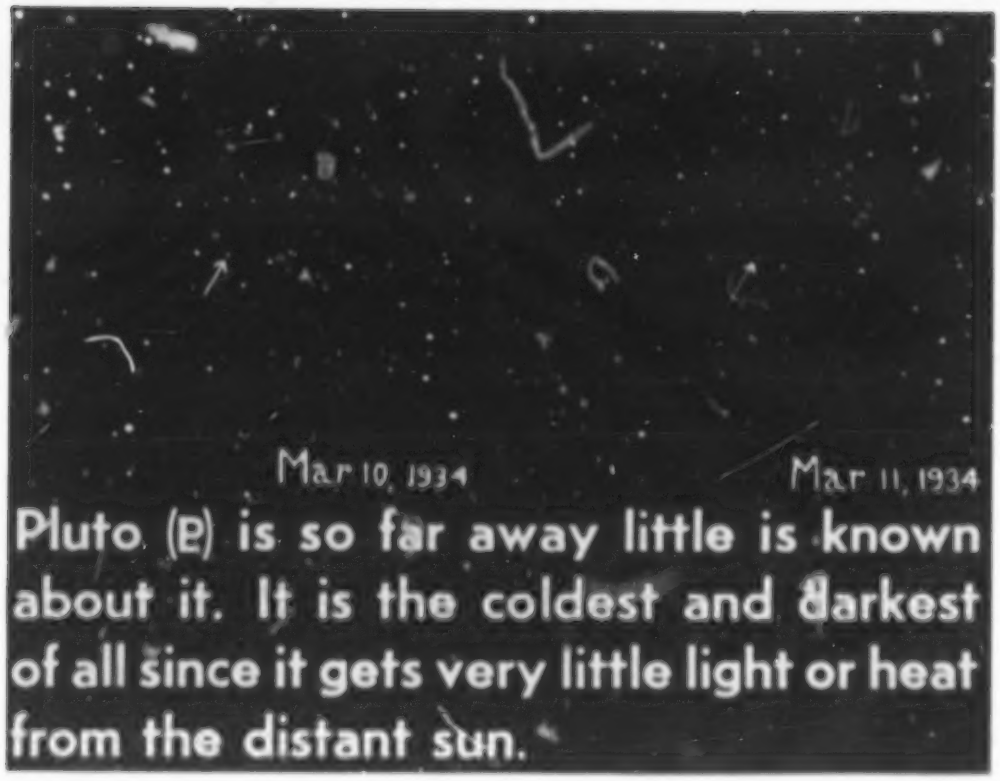

Mar 10, 1934
Mar 11, 1934
Pluto (P) is so far away little is known about it. It is the coldest and darkest of all since it gets very little light or heat from the distant sun.

Figure 15A, Filmstrip Original, Frame 40

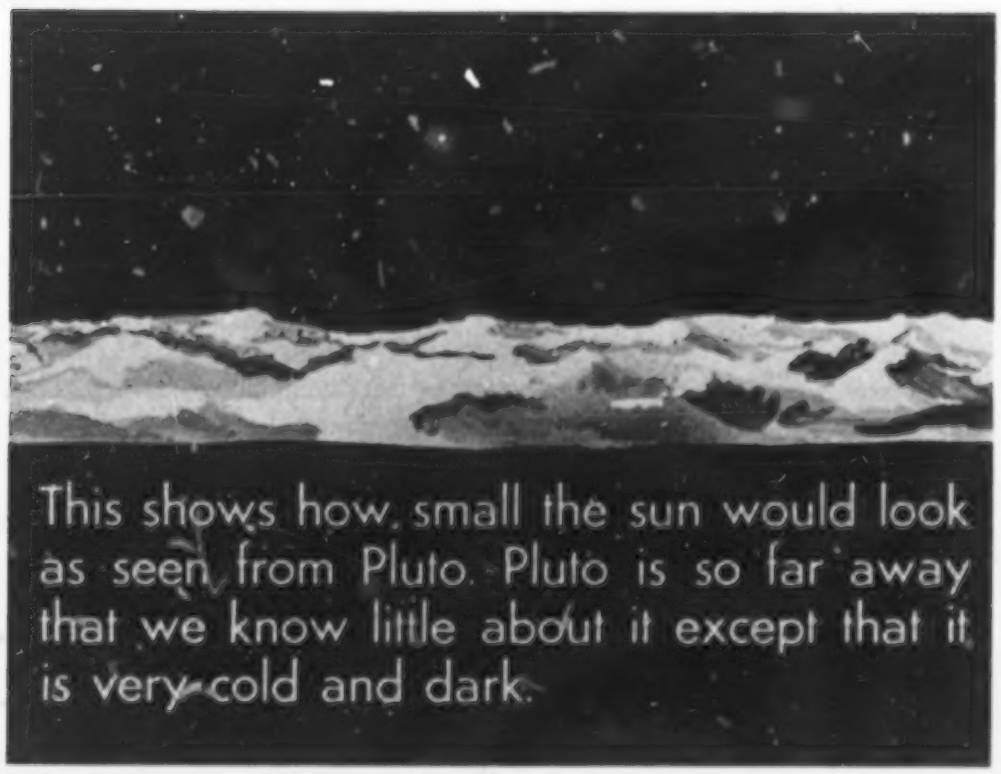

This shows how small the sun would look as seen from Pluto. Pluto is so far away that we know little about it except that it is very cold and dark.

Figure 15B, Filmstrip Revision, Frame 40

The following item was included in the testing instrument:

50. Of all the planets in our solar system, Pluto is:

1. the coldest and darkest
2. the heaviest
3. the brightest
4. the smallest

TABLE XXXI

Proportions of Students Selecting Various Responses to Item 50

Item 50 - DELAYED TESTING

	Grade 5		Grade 7		Grade 11	
	FSO	FSR	FSO	FSR	FSO	FSR
1. x	43	39	48	48	42	43
2.	5	1	1	2	0	1
3.	2	6	5	2	1	3
4.	42	47	40	47	53	52

TABLE XXXII

Proportions of Students Selecting Various Responses to Item 50

Item 50 - IMMEDIATE TESTING

	Grade 8		Grade 11	
	FSO	FSR	FSO	FSR
1. x	86	83	93	80
2.	4	2	0	0
3.	0	0	0	0
4.	12	15	7	18

The test results show that the revision did not do any better in communicating the idea that Pluto was the coldest and darkest planet. Results of the immediate testing instrument show the original doing slightly better, in fact.

Neither caption said anything about Pluto being the smallest planet, yet nearly half of the students in the delayed testing selected choice 4. Even in the immediate testing group, about one student in six indicated that he thought Pluto was the smallest planet in the solar system. Of course, both pictures implied that Pluto <u>looks</u> small as seen from the earth, but neither indicates relative size.

REVISIONS THAT WORKED AND THOSE THAT DID NOT

It is difficult to categorize the changes that are shown in the previous several pages, but perhaps a summary may be useful. The following discussion lumps several specific changes together and attempts to evaluate them.

Changes to the pictorial element. Greater or lesser iconicity seemed indicated in six frames. In four cases the revision appeared to "pay off", although not always statistically significantly within subgroups.

In three cases, larger labels replaced smaller labels, each time with positive effect. Adding labels where none had been before did not pay off, however, although it would appear that it should.

When a frame pictured a sizeable number of items that were to be compared in some way, it appeared useful to arrange the items so that the comparison could be grasped by reading from left to right. At least, this appeared to be superior to a random or "artistic" arrangement.

The following revisions seemed to be promising when they were advanced, but did not result in greater numbers of correct responses to the related test items: adding attention-directing arrows or making existing arrows more prominent, adding a referent such as a scale for size comparison, and organization in order of size.

Some revisions seemed to "backfire". A table substituted for a diagram, and a unit frame split in two proved to be bad revisions from the standpoint of the students' learning.

Changes to captions were somewhat more uniformly successful, but not always consistently so. Taking pains to make the caption speak the exact truth "paid off" to some extent twice and had no apparent effect once. One revision of this kind found the investigators tangling the learners in a complex caption that elicited fewer correct responses on the test item than did the original. Similarly, the addition of a qualifying phrase seemed to work well on one occasion, and to be detrimental on another.

The substitution of words for numbers (million for 1,000,000) had a positive effect, but the addition of a common referent in a caption had no measurable effect.

On the one occasion when the caption was moved from the top of the frame to the bottom, the revision appeared to be mildly successful. Splitting a long, one-sentence caption into two sentences was an ineffectual change.

None of the changes--those to the picture or those to the caption--can be generalized. They are merely suggestive of further lines of investigation.

DIFFERENCES IN MEAN SCORE

As shown by Table XXXIII, the student groups averaged from about 53 per cent to about 85 per cent correct responses on the achievement test as a whole. The filmstrip revision did not, however, result in statistically significantly higher average numbers of correct responses to test items, either when the test was administered after the first forty frames of the filmstrip

TABLE XXXIII

Statistical Summary of Groups and Total Results

STATISTIC	DELAYED TESTING						IMMEDIATE TESTING			
	Fifth Grade		Seventh Grade		Eleventh Grade		Eighth Grade		Eleventh Grade	
	FSO	FSR	FSO	FSR	FSO	FSR	FSO	FSR	FSO	FSR
Number	82	82	94	95	108	99	57	59	42	39
Mean correct responses	26.67	28.63	31.17	33.01	33.88	33.14	38.11	38.12	40.67	42.56
Total possible correct	50	50	50	50	50	50	50	50	50	50
Difference		1.96		1.84	.74			.01		1.89
Standard error of difference		1.24		1.20	1.13			1.02		2.15
Standard deviation	6.80	7.00	7.25	6.75	6.07	6.92	6.01	6.69	4.52	5.62
Kuder-Richardson #21 Reliability Coefficient	.75	.77	.79	.77	.72	.78	.76	.81	.74	.82

were projected or when it was administered piecemeal after each separate frame. This lack of success can be attributed only to (1) not enough revisions that paid off well, and (2) the existence of a limited number of revisions that actually proved to be detrimental.

CONCLUSION

Certain revisions were successful, both in pictorial and in caption portions of the filmstrips. In subsequent revisions, the strengths revealed in the changes will be capitalized on, and the negative results of the revisions that failed will be eliminated.

It has been shown that a filmstrip producer and his staff and a university research team can work together effectively to test out successive revisions of filmstrip materials.

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APPENDIX A

Testing Schedules

1. Lewistown, Pa.

2. Mill Hall, Pa.

PROPOSED FILM AND FILMSTRIP

TESTING SCHEDULE FOR LEWISTOWN

Morning: Wednesday, February 24, 1960

	Mr. Morrison	Mr. Thorne
High School (grade 11)		
8:50-10:25	11a (aud) FO	11'a Library FSO
10:30-12:10	11'a (aud) FR	11a Library FSR

Notes: Take 75 lap boards for aud. (H.S. will furnish balance). Take screen for library (large size).

Afternoon:

Elementary School - Buchanan (grade 5)		
1:00-2:30	5a, 5'a Room 235 FO	5b, 5'b Room 237 FSR

Morning: Thursday, February 25, 1960

Junior High School (grade 7)		
8:40-10:05	7-5a, 7-6a FO Room 101	7-5b, 7-6b FSO Library
10:10-11:40	7-5b, 7-6b FR Room 101	7-5a, 7-6a FSR Library

Notes: Take screen for library (large size). Additional chairs will be needed in library. Large lens for filmstrip projector.

Afternoon:

Elementary School - Buchanan (grade 5)		
1:00-2:30	5b, 5'b FR Room 235	5a, 5'a FSO Room 237

PROPOSED FILM AND FILMSTRIP

TESTING SCHEDULE FOR LEWISTOWN

Morning: Friday, February 26, 1960

Junior High School (grade 7)

8:40-10:05	7-1a, 7-2a FR Room 101	7-1b, 7-2b FSR Room 100
10:10-11:40	7-1b, 7-2b FO Room 101	7-1a, 7-2a FSO Room 100

Note: No lap boards necessary in either room.

Afternoon:

Elementary School - Logan (grade 5)

1:00-2:30	5e FO Room 7	5'e FSR Room 8

Morning: Monday, February 29, 1960

Junior High School (grade 7)

8:40-10:05	7-7b, 7-4b FR Room 101	7-7a, 7-4a FSR Room 100
10:10-11:40	7-7a, 7-4a FO Room 101	7-7b, 7-4b FSO Room 100

Afternoon:

Elementary School - Logan (grade 5)

1:00-2:30	5'e FR Room 7	5e FSO Room 8

PROPOSED FILM AND FILMSTRIP

TESTING SCHEDULE FOR LEWISTOWN

Afternoon: Tuesday, March 8, 1960

Elementary School - Seventh Ward (grade 5)

1:00-2:30	5c, 5'c FR Room 20	5d, 5'd FSO Room 21

Afternoon: Wednesday, March 9, 1960

Elementary School - Seventh Ward (grade 5)

1:00-2:30	5d, 5'd FO Room 20	5c, 5'c FSR Room 21

Notes: 5 and 5' are random halves of a fifth grade room.

5a and 5b are fifth grade rooms in the same school, as are 5c and 5d. 5e is fifth grade in the school having only one fifth grade room.

7-1, 7-2, 7-4, 7-5, 7-6, 7-7 represent established sections of grade 7, a's and b's represent random halves of sections.

SCHEDULE FOR BALD EAGLE-NITTANY JOINT AREA SCHOOLS

May 10, 1960 (Tuesday)

Grade 8 - 4 sections of approximately 130 students

A.M. 8:15-10:00	*FSR	*FSO
	Auditorium	Room 31
(Third period starts at 10:10 a.m.)	819-A	819-B'
	815-A	815-B'
	827-A	827-B'
	8-9-A	8-9-B'

Grade 11 - 4 sections of approximately 99 students

P.M. 12:45-2:15	*FSO	*FSR
	Auditorium	Room 31
(Must finish by 2:20 p.m.)	1116-A	1116-B'
	1128-A	1128-B'
	1131-A	1131-B'
	1112-A	1112-B'

May 11, 1960 (Wednesday)

Grade 11 - 4 sections of approximately 99 students

A.M. 8:15-10:00	*FR	*FO
	Auditorium	Room 31
(Third period starts at 10:10 a.m.)	1116-B'	1116-A
	1128-B'	1128-A
	1131-B'	1131-A
	1112-B'	1112-A

Grade 8 - 4 sections of approximately 130 students

P.M. 12:45-2:15	*FO	*FR
	Auditorium	Room 31
(Must finish by 2:20 p.m.)	819-B'	819-A
	815-B'	815-A
	827-B'	827-A
	8-9-B'	8-9-A

*FSR - Filmstrip Revision
FSO - Filmstrip Original
FR - Film Revision
FO - Film Original

Experiment will furnish: 65 lap boards, 1 screen, 2-16mm film projectors.

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APPENDIX B

		Page
1.	Memorized Instructions for Introducing the Filmstrip to Students Under the Delayed Testing Program.	82
2.	Test Instructions Given to Students Under the Delayed Testing Program.	83
3.	Memorized Instructions for Introducing the Filmstrip to Students Under the Immediate Testing Program.	84

Memorized Instructions for Introducing
the Filmstrip to Students Under the
Delayed Testing Program.

Good morning - I'm Mr. Thorne from The Pennsylvania State University. At the University we are working on a project to find out how filmstrips can be more effective in the classroom, and we have come to your school hoping for your assistance and cooperation.

The filmstrip we have selected is from a series of filmstrips entitled, "The Earth and the Universe", produced by the Society for Visual Education. From this series we have selected the filmstrip called, "The Sun and Its Planets". We feel this particular filmstrip is one that all of you, both boys and girls, will enjoy.

After you have seen this filmstrip, I would like to know what you think of it and would like you to answer some questions about it. So - pay close attention and try to remember what you see.

Test Instructions Given to Students
Under the Delayed Testing Program.

Boys and girls I want you to look at the pencils you have just received. These pencils are especially made for automatic machine scoring. The lead is very soft and will break under the normal pressure you are used to giving a regular writing pencil. If you do break the lead during the test, raise the pencil over your head and one of the teachers will give you another one.

I have here in my hand a copy of the special I.B.M. score sheet. In the upper left hand corner is a space for your name. Please write or print - whichever you do best - your last name first - then your first name and middle name, if you have one. (continuing on across the heading until completed)

Do you see the example printed on the score sheet? Do you see how to fill in between the dotted lines? Notice how the dark area does not extend above or below the dotted lines! The answer is entirely within the dotted area! This is how you are supposed to do it, too!! Move your pencil up and down several times so the dotted area is nice and dark.

If you mark the wrong dotted area and wish to change your answer - be sure to erase the first mark. Do not cross it out! Erase it! Remember - your tests will be scored by machine and the machine cannot see your cross marks. The machine will see two filled spaces and mark the answer wrong. Be sure to erase your first mark!

When you are finished with your test turn your papers face down on your desk and remain quiet until everyone is finished.

Memorized Instructions for Introducing the Filmstrip to Students Under the Immediate Testing Program.

Good morning - I'm Mr. Thorne from The Pennsylvania State University. At the University we are working on a project to find out how filmstrips can be more effective in the classroom, and we have come to your school hoping for your assistance and cooperation.

The filmstrip we have selected is from a series of filmstrips entitled, "The Earth and The Universe", produced by the Society for Visual Education. From this series we have selected the filmstrip called, "The Sun and Its Planets". We feel this particular filmstrip is one that all of you, both boys and girls, will enjoy.

You will notice that where you are seated here in the auditorium, it is well lighted and perfectly suited for reading and writing.

First - Do all of you have lap boards?

Second - Do all of you have the special I.B.M. pencils the boys at the door were passing out? Just a word about these pencils - probably all of you have used them before, but I want to mention that the lead is very soft and will break very easily. Please do not use them like a regular pencil! Without too much pressure they will make a nice dark mark. If you do break your pencil point during the test - merely raise your hand, hold the pencil and one of the teachers will give you another one.

Third - Do all of you now have a copy of the I.B.M. score sheet? (at this time score sheet was explained and filled out with necessary information)

Fourth - Do you all have a copy of the test? Please keep them face down on your lap boards. The teachers assisting will take your lap boards and all materials if you do not obey instructions.

Fifth - Now pay close attention! Directly behind you is the filmstrip projector and a tape recorder. The frame you will be tested on will be flashed on the screen and left there for a specified period of time. The tape recorder will play the verbal content on the frame and then the filmstrip will be left on the screen for another specified length of time. WHEN THE FILMSTRIP IS TURNED OFF I WILL TELL YOU WHEN TO TURN THE PAGE ON YOUR TEST PAPER. PLEASE DO NOT TURN ANY PAGE WITHOUT BEING TOLD TO DO SO!

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APPENDIX C

Delayed Testing Instrument

THE SUN AND ITS PLANETS

Directions and an example are given on the answer sheet. Your test administrator will further explain the directions to you. If you do not understand the directions or have any questions, be sure to ask the administrator before the test begins. Do not make any marks on this booklet. Indicate all answers on the answer sheet.

1. Which of the following lines has in it the name of something that is not in our solar system:

    1. the sun, comets, meteors
    2. planets, moons, asteroids
    3. moons, constellations, the sun
    4. asteroids, planets, meteors

2. The sun is a star. In our solar system it is located in the:

    1. northern part
    2. southern part
    3. center
    4. outer part

3. Of what is the sun made:

    1. solid coal that will burn forever
    2. like earth, but covered with hot lava
    3. a globe of rock but polished like nickel
    4. a globe of glowing hot gases

4. Approximately how many earths would it take to equal the diameter of the sun:

    1. 50
    2. 100
    3. 1,000
    4. 1,000,000

5. If the sun were hollow, how many of our earths packed together would it take to fill it:

    1. one fourth of an earth
    2. 1,300,000 earths
    3. 130,000 earths
    4. 3,000,000 earths

6. The sun gives light and heat. This heat comes from:

    1. the reflected light from the stars
    2. energy like that of atomic fusion
    3. fires burning on the surface
    4. molten lava on the surface

7. The sun turns on its axis once:

   1. each day
   2. every 10½ days
   3. every 24½ days
   4. each year

8. We can tell that the sun turns on its axis because of:

   1. the changing position of sun spots
   2. the difference in cloud formations
   3. its effect on the earth's orbit
   4. all of these

9. The whole solar system moves through space at:

   1. 12 miles per second
   2. 32 miles per second
   3. 52 miles per second
   4. 62 miles per second

10. The planets revolve around the sun in a circular motion called:

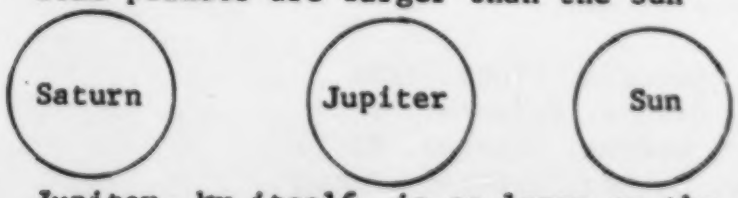
   1. positions
   2. rotations
   3. revolutions
   4. orbits

11. At night we can see some of the planets shining in the sky. These planets shine because of:

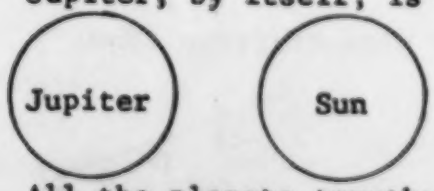
   1. the glare of the polar caps
   2. light reflected from the planets' moons
   3. fire on the surface of the planet
   4. the reflected light of the sun

12. In comparing the sun to the planets in our solar system in <u>size</u>, which of the following is correct?

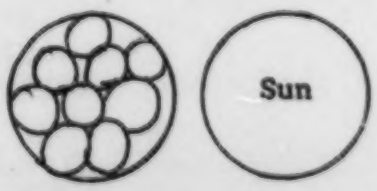
   1. some planets are larger than the sun



   2. Jupiter, by itself, is as large as the sun

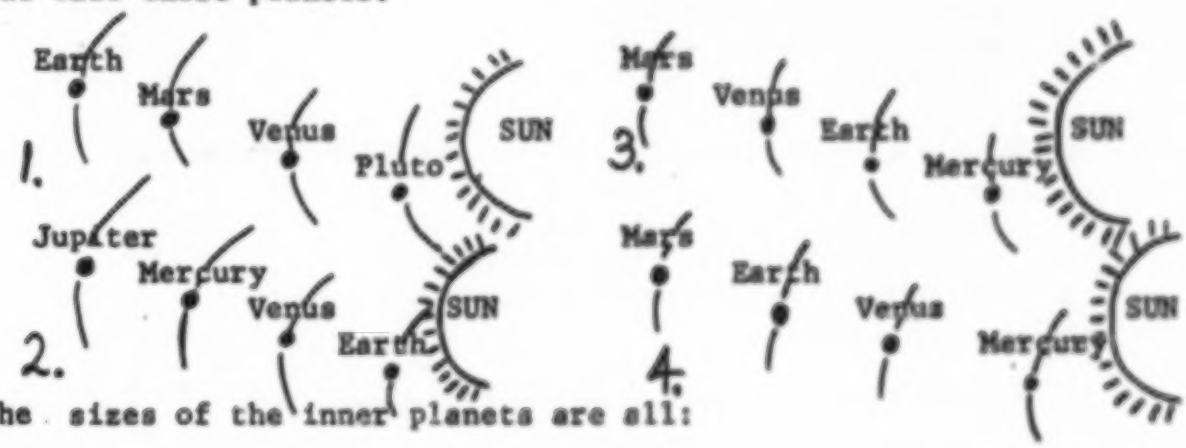


   3. All the planets together are as large as the sun



   4. All the planets would fit in a small corner of the sun

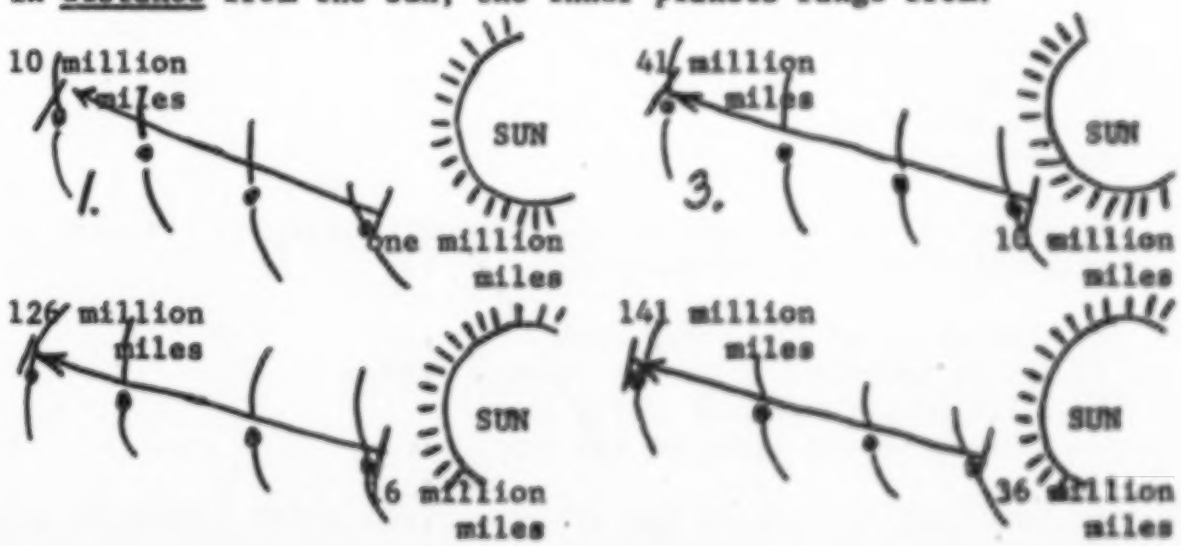
13. The four planets nearest the sun are called the <u>inner</u> planets. We call these planets:



14. The sizes of the inner planets are all:

    1. about the same as the outer planets
    2. all larger than the outer planets
    3. quite a bit smaller than the outer planets
    4. somewhat larger than the outer planets

15. In <u>distance</u> from the sun, the inner planets range from:

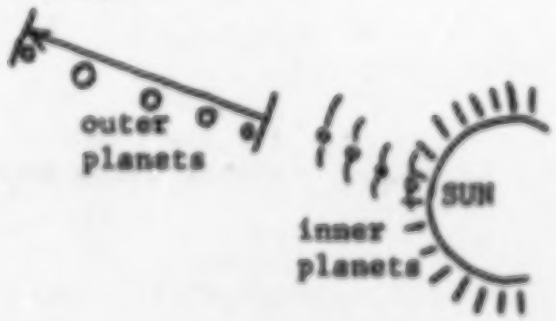


16. The five planets farthest from the sun are called the outer planets. By name we call these planets.

    1. Saturn, Uranus, Neptune, Pluto, Mars
    2. Earth, Jupiter, Uranus, Neptune, Pluto
    3. Jupiter, Saturn, Uranus, Neptune, Pluto
    4. Neptune, Uranus, Saturn, Jupiter, Earth

17. In distance from the sun, the outer planets range from:

    1. 80 to 210 million miles
    2. 450 to 900 million miles
    3. 480 to 3,665 million miles
    4. 540 to 7,671 million miles



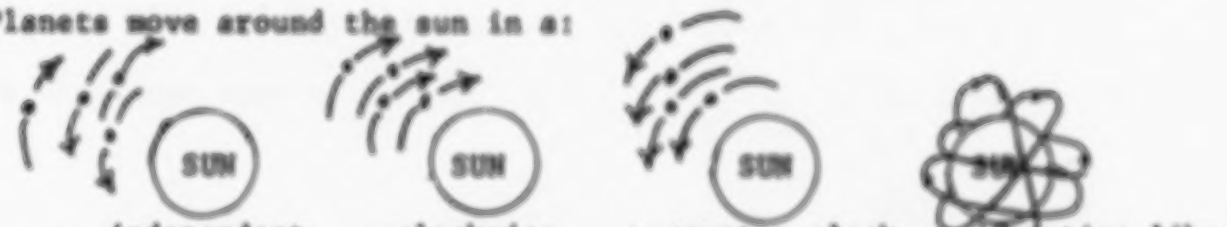
18. The <u>largest</u> of the outer planets is called:

1. Saturn
2. Jupiter
3. Neptune
4. Uranus

19. The largest planets in our solar system are:

1. Neptune, Jupiter
2. Saturn, Pluto
3. Uranus, Neptune
4. Jupiter, Saturn

20. Planets move around the sun in a:



21. What is a <u>year</u> in terms of each planet in the solar system:

1. one half of a revolution
2. the time it takes to go around the sun
3. the time it takes to turn on its axis
4. the speed of rotation

22. The inner planets have short years because they have:

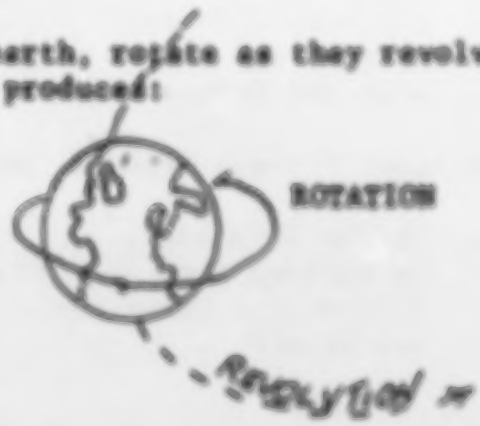
1. shorter orbits and travel rapidly
2. longer orbits and travel rapidly
3. shorter orbits and travel slowly
4. longer orbits and travel slowly

23. The <u>outer</u> planets have longer years because they:

1. are so far from the sun
2. travel very slowly
3. have longer orbits
4. all of these

24. Most of the planets, like our earth, rotate as they revolve around the sun. This rotation produced:

1. seasons
2. polar caps
3. nights and days
4. climates



25. Not all the rotation periods of the planets are known. Which two are unknown:

1. Mercury and Uranus
2. Venus and Pluto
3. Jupiter and Saturn
4. Neptune and Mars

26. When seen without a telescope, a planet looks much like a star, though the brighter planets:

1. shine with a somewhat steadier light
2. blink at you steadily
3. look much like comets
4. are a different color than bright stars

27. Over a period of time a planet appears to move among the stars in the direction of:

1. North
2. South
3. East
4. West

28. Mercury and Venus are seen only near the sun either at dawn or at sunset because:

1. they are too dim
2. at that time they are not hidden by clouds
3. they are moving too fast
4. they are between the sun and earth

29. When "West" of the sun Mercury and Venus rise before the sun and are seen as:

1. evening "stars"
2. moons
3. morning "stars"
4. comets

30. Most of the planets can be found at night:

1. along the path of the sun and moon
2. directly overhead
3. next to the "milky way"
4. near the horizon

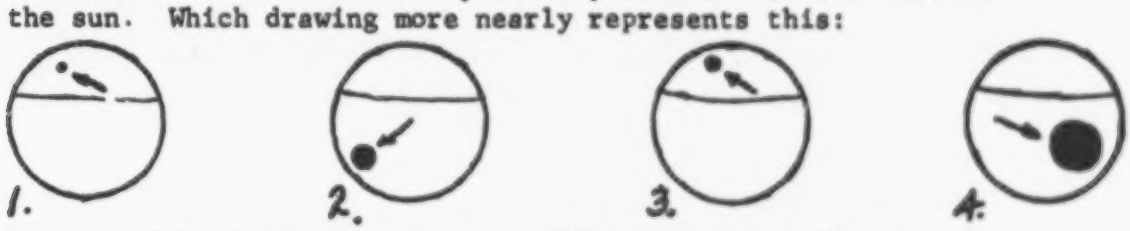
31. At night Uranus, Neptune, and Pluto can be seen:

1. by the bare eye
2. by looking thru colored glass
3. only with a telescope
4. not at all

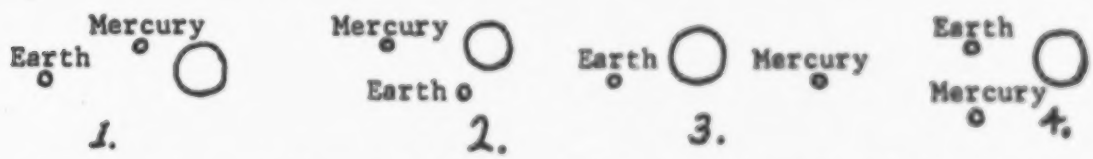
32. To study the stars a telescope may be used to:

1. brighten the planet images
2. magnify the planets
3. see them as they really are
4. all of these

33. From earth we can see Mercury as it passes across the face of the sun. Which drawing more nearly represents this:



34. Mercury, like Venus, shows phases like our moon. The reason for this is because the positions of the earth, sun and Mercury are like one of the figures shown below. Which one:

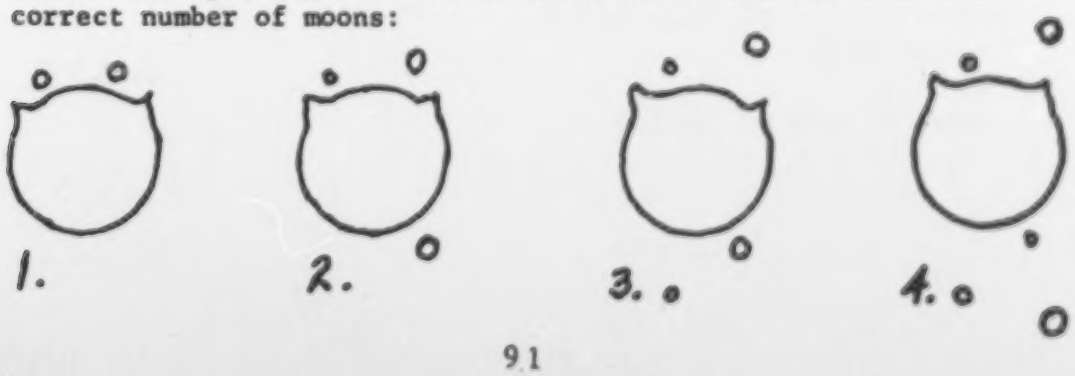


35. Do you remember seeing a picture of Mars in the filmstrip? What outstanding features do you remember:

36. A very clear picture of Jupiter was also shown. Choose the picture which more closely reminds you of the filmstrip:

37. Select from the four drawings below the picture that more closely resembles the picture of <u>Saturn</u>:

38. In the four pictures of Uranus below choose the one with the correct number of moons:



39. Neptune was found:

1. when its shadow hid Pluto from our microscopes
2. when it was discovered something was disturbing the orbit of Uranus
3. when it passed to the right of the sun 113 years ago
4. by telescope after its location was mathematically predicted

40. Pluto was discovered when a section of the sky was photographed and it was noted that a star seemed to have:

1. changed its position
2. become suddenly brighter
3. disappeared from the picture
4. passed behind the sun

41. Life on the planets seems doubtful in the case of Mercury since:

1. one side is very hot
2. it has no air or water
3. one side is very cold
4. all of these

42. Venus is completely covered by clouds, so very little is known about it. We do know that it is:

1. the smallest planet in our solar system
2. the fastest moving planet of the inner planets
3. larger than our earth
4. the brightest of the planets

43. We know that Mars is:

1. completely covered with ice
2. very hot during the day
3. mostly desert with some vegetation
4. nothing but red sand

44. We know that Mars has:

1. two tiny moons
2. very little water
3. air that is probably very thin
4. all of these

45. The markings that we can see on Mars are considered by some to be:

1. wide strips of vegetation
2. river beds
3. canals
4. tops of old mountains

46. We know that the air on Jupiter is composed of:

1. poisonous carbon monoxide and ethane gas
2. poisonous ammonia and methane gas
3. poisonous carbon dioxide and ammonia
4. hydrogen and poisonous methane gas

47. If you were to look through a telescope you could see circling Jupiter:

1. six moons
2. nine moons
3. twelve moons
4. fifteen moons

48. It is easy to remember the number of moons circling Saturn, because it is the same number as:

1. the moons of Mars
2. the planets in our solar system
3. the moons of Jupiter
4. none of these

49. Life on Uranus and Neptune would be impossible for several reasons. One of which is:

1. the high temperature
2. that it is extremely cold
3. large land areas are covered with ice
4. not enough water

50. Of all the planets in our solar system Pluto is:

1. the coldest and darkest
2. the heaviest
3. the brightest
4. the smallest